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1948

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A BRIEF HISTORY OF ACADEMY PUBLICATIONS

BY MAURICE E. PHILLIPS

Scientific Editor, Academy of Natural Sciences of Philadelphia

INTRODUCTION

When the hundredth annual volume of a continuous scientific serial is published in the United States, it is an event of some distinction. Very few scientific organizations in this country, dealing exclusively with the natural sciences, have achieved that point in their publication history. In this issue, the Academy of Natural Sciences of Philadelphia celebrates a long and distinguished career in the dissemination of knowledge in its particular field. While the *Proceedings* has been our most important publication, it does not by any means cover the life span of the institution. Begun in 1841, it was preceded by the first series of the *Journal,* which was initiated in 1817, five years after the founding of the Academy.

A few other science institutions in the United States were founded at an earlier date or at about the same time. Of those which have continued printing scientific papers until recent years, all, so far as determined, have either dealt to a considerable extent with other types of research or have discontinued their earlier serial publications and substituted other titles. As a consequence runs of one hundred volumes in natural history serials in this country are almost non-existent.

In the late 18th and early 19th centuries, there was a great flurry in the establishment of natural history and other societies. The Classical Revival had just reached America and men apparently felt the urge to associate themselves with cultural endeavors in the sciences and arts. They formed groups in many cities, both large and small, and proceeded to organize a Lyceum, an Institute, an Academy, a Literary and Philosophical Society, or a natural history, geological or mineralogical " Cabinet." Some of these groups prospered; many more shortly fell into oblivion. It seems obvious that the success or early dissolution of these ventures depended to a considerable extent upon two factors; the early appearance within the group, of men of outstanding talent in their fields, and their association with men who could and did lend generous financial support to the cause. The

Academy of Natural Sciences of Philadelphia was fortunate, in its most critical periods, in both these respects. A long list of institutions for the study of nature could be assembled which passed out of existence after a few short years because some spark was lacking in their makeup. Many of them published from one to five or six volumes, or none at all. The many attempts at this time to form active institutions for research and publication, is probably a measure of the need felt by natural scientists for an outlet for their investigations.

As a comparative study, it might be well to mention a few of the more important early ventures other than this Academy which did succeed. This résumé will reveal the scarcity of journals in which scientists could expect to have the results of their natural history research published.

The American Philosophical Society (Philadelphia, 1727) is the oldest scientific institution in the United States. It was founded by Benjamin Franklin as the Junto in 1727. Previous to the formation of the present organization, there were in Philadelphia two small groups whose purpose was the advancement of knowledge. One was, the *American Philosophical Society* (1742) and the other, the *American Society for Promoting Useful Knowledge in Philadelphia* (1766). These two societies united in 1769 to form the present *American Philosophical Society held at Philadelphia for Promoting Useful Knowledge.* The date of founding of the institution has been officially established as 1727. Six volumes of the first series of its *Transactions* were issued from 1771 to 1809, followed by 38 volumes, new series, 1818 to 1948. The *Proceedings,* established in 1838, continue to the present and are in the 92nd volume. A recent *Memoir* series was commenced in 1935. With the founding of the Academy of Natural Sciences, the American Philosophical Society became less active in natural history publication, as most of the naturalists of the Society were also Academy members.

The *American Academy of Arts and Sciences* (Boston, 1780) issued the first part of its *Memoirs* in 1785, and as only five volumes had appeared by 1850, it is obvious that in the early years, this serial was not an important research outlet. The *Memoirs* is now apparently in its 19th volume. Its *Proceedings* (1848) has continued to the present time and has reached its 76th volume.

The Medical Repository (New York City, 1797) has been designated as, " the first strictly scientific periodical in the United States." Though it was devoted largely to medical subjects, many natural history papers were published in it. Twenty-two volumes appeared from 1797 to 1822. Thus, five years after this Academy started its Journal, the *Medical Repository* was no longer issued.

The *American Mineralogical Journal* (New York City, 1810) should be noted here, for though it published but one volume, it has been referred to as, " the first strictly scientific journal to devote itself primarily to a special field of natural history."

The *Lyceum of Natural History of New York* (1817) started the publication of its *Annals* in 1824, and continued through eight volumes to 1867. A large mass of additional natural history material emanated from this organization, but it was issued through the *American Monthly Magazine and Critical Review* and through the *American Journal of Science.* The Lyceum became, in 1876, the *New York Academy of Science.* This latter society continued the *Annals* under its own name from 1879 to the present, a series of 50 volumes.

The *American Journal of Science* (New Haven, 1818) presents one of the most imposing arrays of published scientific papers to be found in the United States. Though changing its name after the first volume to the *American Journal of Science and Arts,* and back again to the original name in 1880, this serial has been continuous since 1818, and is now in its 246th volume. It has not, however, devoted itself exclusively to the natural sciences, but has included much general scientific material, especially in chemistry and physics, and, in its earlier volumes, to the arts as well. At least five or six natural history societies have made use of this journal to publish their research.

In addition to these important organizations, the *Geological Surveys* of various states printed valuable and extensive works in natural history. Oddly enough, in the earlier years, many taxonomic papers in both zoology and botany were included in their publications.

The activities of the Academy of Natural Sciences of Philadelphia have never been directed in any large measure to experimental biology. The presence on its staff of many medical men, particularly in its early history, has led at times to research in anatomy, physiology and other branches related to medical science. Ethnology and anthropology loomed large at certain periods, and though geology and mineralogy have always been important segments of research, the traditions, staff and equipment of the institution have always been built upon the cornerstone of descriptive and systematic biology. It remains to this time, 137 years after its founding, one of the very few institutions in America which is an outstanding taxonomic island in a sea of experimental biology.

In the beginning, this restriction to systematic research was but natural. The study of most living organisms had then scarcely progressed beyond the stage of description and classification. However, through subsequent years, the workers of the institution have continued to be largely disciples of Linnaeus. Its outstanding library is a monument to the genus and species, and the eminent assemblage of classified specimens, particularly of types, is one of the fine reference collections for the systematic biologists of the world.

The Academy was founded at a particularly opportune time for this kind of research. The plant and animal kingdoms were still virgin territory for taxonomic investigation. Yet, as has been shown, there had been set up in this country very few outlets for publications in systematic biology and there were then very few important museums for the housing of collections.

It was only natural that the establishment of the Academy and its museum, and the initiation of its first publications, should draw to its doors and to its membership most of the important American naturalists of the early 19th century. Its membership lists of that period form, as a result, a veritable bluebook of the men who were later to be considered among the fathers of their respective branches of natural science in America. In consequence of the presence of this " remarkable coterie of naturalists," Philadelphia has been referred to as the metropolis of natural history in this country.

Few laymen appreciate with what a powerful surge science has developed in recent times; that such an overwhelming proportion of present scientific knowledge has been gained in so small a segment of human history. For more than a thousand years the ideas of Aristotle, the greatest biologist of antiquity, maintained a lasting and significant influence upon the whole of scientific thought. It was, almost unbelievably, only about 200 years before the founding of the Academy in 1812, that Francis Bacon had expressed the fundamental, and at that time revolutionary, concept that a knowledge of nature is acquired only by careful observation and experiment; that experience is the sole source of knowledge, and not fantasy, mysticism and speculation. The entire trend of scientific thought in the Middle Ages had been stifled by philosophical subtleties. It was less than 200 years since Harvey had discovered the true course of the blood; and while a hundred and fifty years earlier van Leeuenhoek had built a microscope of sorts, the Academy was a well-established institution before microscopes were developed which were useful to scientists in the modern sense. About 75 years had passed since Linnaeus had erected the framework of modern taxonomy, Pasteur had yet to lay the ghost of " spontaneous generation," and half a century was still to elapse before Charles Darwin's *Origin of Species* startled the world. The Academy treasures a letter from Darwin acknowledging his election as a corresponding member.

" It is believed that the prosperity of the Academy depends largely on its publications and without them it would be unknown and virtually cease to exist in a scientific sense." This statement, made by President W. S. W. Ruschenberger in his annual report of the Academy in 1878, is just as true today, and one of the practical expressions of this value is found in relation to the library. No other factor has been of so much importance in assembling the library collection as has the exchange of our serials for those of other institutions, both foreign and domestic. This exchange extends far back to our early volumes and has resulted in extensive runs of scientific periodicals and society publications.

For the purpose of determining questions of priority in taxonomic papers, William J. Fox compiled a list of publication dates of the various parts of the first series of the *Journal,* the first five volumes of the Second Series, and of the *Proceedings* to volume 22. This appears in the introductory matter of the Academy's *Index* of 1913. These dates, of necessity, were often based upon the recorded dates of receipt by other institutions. For many years now the Academy has held strictly to a policy of mailing separates of scientific papers and of separate volumes, on the exact day of issue as printed on the cover. These " date separates " are sent to a selected list of institutions scattered throughout the world.

It is recorded that Thomas Say did much of the editorial work on our earlier volumes. However, it is to be assumed that thereafter the Publication Committees were actually responsible. Not until the 28th volume of the *Proceedings* in 1876 is an editor officially designated. Edward J. Nolan held this post from that date until 1919 and was followed by: William J. Fox, 1920-1937; C. Bernard Peterson, 1938-1943; the present editor since that date.

Acknowledgments

Grateful acknowledgment is made here to the many members of the Academy's staff for helpful suggestions in the preparation of this paper. Librarians of various Philadelphia institutions have assisted in the location of rare material. The bibliography of Academy publications by E. J. Nolan (Proc. 1901), the only other list that has been printed, was helpful in locating older items. The unpublished history of the Academy, finished by Dr. Nolan in 1912, has been a fruitful source of historical information.

ACADEMY AUTHORS

The workers who contribute to its publications are the greatest asset of any scientific institution. Its prestige must eventually depend upon their achievements. Just as unpublished research of even the highest quality is fruitless, so may ill-conceived and poorly executed work contribute little to the publication in which it is reported. In the 131 years since the establishment of its *Journal,* the Academy has published the work of such a host of authors that space does not permit even recording their names. However, it is well to recall here some of the men whose writings have helped most to build the reputation of the institution.

Almost from its founding, the work of the Academy has been divided into departments representing the different branches of natural history. As the age of specialization has gradually enveloped us, research men have, by their work, automatically classified themselves into one of these branches; this was far from true of the old fashioned naturalist. It seems certain, with respect to the latter, that seeing so much unexplored territory about him in every realm of nature, he could not resist the temptation to sample the delights of many. He often developed one or more favorite specialties, only to reach out from these into what must have seemed temporarily greener pastures, often even bridging the gap between the botanical and zoological sciences. There were many men of this type who contributed in a great measure to the development of Academy publications. They can not all be discussed here in detail but two or three typical examples might be mentioned.

Joseph Leidy was perhaps the most versatile Academy author. A pioneer worker in American vertebrate paleontology, protozoology, parasitology, and bacteriology, he was also a respected writer and teacher in the sphere of human anatomy. The number of his titles (555) in the *Journal* and *Proceedings* exceeds that of any other worker and these titles cover an incredible breadth of subject matter. Edward Cope is listed below as an ichthyologist and his contemporary, Theodore Gill, said of him that he had no peer. However, he was also a herpetologist, and a paleontologist and his 233 articles cover many other fields. Thomas Say, one of the founders of the Academy, is claimed by both the entomologists and the conchologists as the father of these respective branches of science in America. It might be said of this type of naturalist, that he had one important advantage over the modern specialist; he was able to develop a broader outlook upon the interrelationships of the various divisions of natural science. In addition, he could easily have had more fun.

Attention should be called here to the importance of the medical man in early natural history research and publication. In any considerable group of such workers in the 18th and early 19th centuries, a large representation of doctors was almost certain to be found. The explanation to this doubtless lies partly in the fact that they were among the few in that period who had received formal academic training in any science associated with natural history. Botany, with its study of herbs, was much closer to medicine then than now and the doctor's training in anatomy and morphology fitted him for activities in descriptive and systematic biology. Of the 52 contributors to the first series of the *Journal*, over one-third were doctors, and the members of the newly formed Biological and Microscopical Section of the Academy in 1868 were almost all of the same profession. It might also be noted that at one period all members of the Publication Committee of the Academy were physicians.

It is difficult to draw any clear-cut line among the contributors to Academy publications with respect to the outstanding importance of their work, and it would be inappropriate for the author to attempt to assess the value of their writings in any detail. However, with suggestions from our scientific staff, the following list of eminent Academy writers has been assembled wholly upon the basis of their works in our own serials. Some names will be found in two or more categories, as it is impossible to restrict them to one.

In the last group, " General Contributors," are the names of some men who published a considerable amount of material on quite a large variety of subjects so that it is difficult to classify them.

ANTHROPOLOGY.—Clarence B. Moore and Samuel G. Morton.

BOTANY.—Elias Durand, Asa Gray, J. W. Harshberger, Thomas Meehan, Thomas Nuttall, Francis W. Pennell, J. H. Redfield, and Horatio C. Wood, Jr.

CONCHOLOGY.—H. B. Baker, W. G. Binney, T. A. Conrad, William H. Dall, W. M. Gabb, Isaac Lea, Henry A. Pilsbry, Thomas Say, George Tryon, and E. G. Vanatta.

ENTOMOLOGY.—Philip P. Calvert, Ezra T. Cresson, Ezra T. Cresson, Jr., William J. Fox, Samuel S. Haldeman, Morgan Hebard, George H. Horn, Charles W. Johnson, John Lawrence LeConte, H. C. McCook, James A. G. Rehn, and Thomas Say.

GEOLOGY AND PALEONTOLOGY.—T. A. Conrad, William H. Dall, W. M. Gabb, Richard Harlan, Angelo Heilprin, Joseph Leidy, William Maclure, F. B. Meek, Samuel Morton, Theodore D. Rand, Horace G. Richards, Lardner Vanuxem, and Joseph Wilcox.

HERPETOLOGY.—Edward D. Cope, Edward Hallowell and Richard Harlan.

ICHTHYOLOGY.—Spencer F. Baird, Edward D. Cope, Henry W. Fowler, Theodore Gill, Charles Girard, David Starr Jordan, and Charles A. Lesueur.

INVERTEBRATE ZOOLOGY.—Joseph Leidy, J. Percy Moore, and Edward Potts.

MAMMALOGY.—Harrison Allen, Henry C. Chapman, and S. N. Rhoads.

MINERALOGY.—F. A. Genth, Edward Goldsmith, Samuel G. Gordon, Frank J. Keeley, George A. Konig, Henry C. Lewis, and Gerard Troost.

ORNITHOLOGY.—James Bond, W. Wedgwood Bowen, John Cassin, Elliott Coues, Rodolphe Meyer de Schauensee, and Witmer Stone.

GENERAL CONTRIBUTORS.—Spencer F. Baird, Edward D. Cope, Samuel S. Haldeman, John LeConte, Joseph Leidy, John A. Ryder, and Benjamin Sharp.

SECTIONS OF THE ACADEMY

Academy by-laws of 1866 state that, " To facilitate and encourage special investigation in any branch of natural science, members of the Academy may form sections and hold meetings in the hall. . . . " Through the efforts of G. W. Tryon, a conchological section was established in that year. This was the first group of its kind to be formed at the Academy. From that time until 1895, seven of these units were developed and two others were projected though not organized. The sections are mentioned here because in some cases they became important, within the framework of the parent institution, as publishers of scientific data. Their productions are listed separately in the bibliography, under their own headings. In 1924, a change in the by-laws of the Academy automatically eliminated all sections and as such they discontinued operation. Brief notations are given below, of these various groups, arranged chronologically as to their dates of formation.

Conchological Section.—Through the efforts of G. W. Tryon, this group was organized in 1866. Next to that of Entomology, it published more material than any other, being responsible for 40 or more volumes. After the death of Mr. Tryon, the membership dropped below that required by the Academy by-laws and the section passed out of existence in 1904.

Biological and Microscopical Section.—In 1868, the Biological department of the Academy, through union with the Microscopical Society of Philadelphia, became the Biological and Microscopical Section of the Academy. Its publications are of minor importance. It was continued to 1924 and then became The Leidy Microscopical Club.

Physics and Chemistry Section.—Application was made and approved in 1872, one meeting was held but, like the projected Geographical Section, this group was never organized.

Botanical Section.—This organization was initiated in 1876, due largely to Thomas Meehan. It published nothing so far as known.

The Entomological Section.—In 1876, the American Entomological Society moved to the Academy and through an agreement, became the Entomological Section. It deserves special mention here because of its large mass of publications. First organized in 1859 as the Entomological Society of Philadelphia, it changed its name eight years later to that under which it became a Section. Since 1876, it has always maintained its corporate identity as the American Entomological Society and though dissolved as a Section in 1924, its association with the Academy has always been so close, that all its publications are included in the bibliography below. Since 1876 it has been housed at the Academy, its extensive collections and library are deposited in this institution, most of its workers have been staff members or officers of both societies, and at least part of its publications are handled by the same editorial department. It is worthy of note that the volume of its scientific publications is considerably more than half that of the Academy itself.

Mineralogical Section.—This division was formed in 1877. Two years later, its scope having broadened, its name was changed to the Mineralogical and Geological Section. Its publications are very restricted.

Ornithological Section.—Though being formed in 1891, considerably later than most of the others, this section was a very active one, but so far as known published nothing.

Anthropological Section.—Formed in 1895, this section lasted but two years. No publications have been credited to it.

EXPEDITIONS

The first publication of the Academy, printed in 1817, is a small *Circular* intended for captains and other voyagers and containing directions for the collection and preservation of natural history specimens. This reveals the eagerness with which members of the institution, even then, sought specimens from distant places.

The importance of expeditions can hardly be overestimated, and they are very closely associated with the publications of the institution. They are the outstanding source of natural history specimens and of observations in the field, as a very large proportion of our published material is based upon the results of some kind of expedition. The naturalist himself is usually an enthusiastic collector and distant regions appear to him more attractive, and indeed they are often more productive of significant material as he and his associates have probably already combed their immediate environment. This was less true a hundred years ago than now, for an examination of our publications shows that at that time approximately 90 percent of the new species being described were domestic forms; today the situation is reversed and approximately 90 percent are exotic. From the earliest days of the Academy, its members individually or in groups, have wandered to distant places in search of the unknown or the rare, returning with new eagerness to classify, describe, and catalogue their findings.

The first organized trip of the Academy for collecting specimens is mentioned, less than four months after its founding. The minutes of the meeting of April 18, 1812, record that the chairman requested the treasurer to engage " a suitable carriage, at common expense " for the purpose of making a mineralogical excursion to the mines of the Perkiomen. Apparently most of " the gentlemen of the Academy " went on this trip. While this can scarcely be designated as an expedition, a trip of 30 or 40 miles by carriage was then a considerable journey.

A complete account of all the expeditions from which the Academy has received material would require a volume of large size. Consequently it will be possible here only to recall some of the major undertakings and to cite examples of different types of expeditions which have contributed so largely to our store of seven or eight million specimens, and indirectly to our publications.

The one-man expedition, whether officially sanctioned or a private enterprise, has been of more frequent occurrence in the institution's history than any other type. Men such as Audubon, Lesueur, Nuttall and Say seemed to have a very definite nomadic impulse which carried them into many wild and distant places, unattended by anyone other than Indians or natives of other lands. However, it was not uncommon for such men to travel in small groups. A typical example of this kind of early expedition is that of Thomas Say, William Maclure, George Ord, and Titian Peale, all members of the Academy, who, in the winter of 1817 made a trip to the coast of Georgia and to northern Florida. They collected many specimens and returned in the spring of 1818 after very nearly being captured by hostile Indians on the St. John's River, Florida.

These small informal enterprises may not have produced great results individually, but the Academy records and publications for over 125 years give evidence that as a whole, they have built up a tremendous mass of material, and have thus been of greater importance than any other type of expedition. They are still a major influence as indicated by the great number of individual expeditions of nearly all the men presently on our scientific staff.

A second type of expedition which deserves a place in this account is the U. S. government project in which Academy scientists took part. The Wilkes U. S. Exploring Expedition of 1838-42, which went around the world, was the first national enterprise of this type. It included two members of this institution—Charles Pickering and Titian Peale. This voyage excited considerable comment over the world, as it was considered unusual that a fledgling republic such as ours should launch so ambitious an enterprise. At least ten scientific articles covering data assembled on this trip appear in our *Proceedings*, and more than one volume relating to it was written for government publication by members of our staff. In our archives may be found the two-volume unpublished diary of the trip, by Charles Pickering.

Another example of an early government expedition which was accompanied by Academy members, and from which the Institution received material, was Major Long's Expedition to the Rocky Mountains in 1819 and 1820. Major Long himself was a correspondent of the Academy. Other members who took part were Thomas Say, A. E. Jessup and Titian Peale. This trip started from Pittsburg and proceeded on the steamboat, "Western

Engineer," down the Ohio to the Mississippi River and up the Missouri. It is unfortunate that C. A. Lesueur could not have been present on this trip to record a true sketch of this unique craft which had the figure of a huge sea serpent at its bow, and extending down the sides. The smoke from its engines belched forth from the mouth of the serpent and must have been an awesome sight to the Indians as it pushed steadily westward.

There are numerous articles, mostly by Thomas Say, in the first series of our *Journal* written about the material collected. With respect to both this expedition and that of Wilkes, the Academy was approached by the Secretary of the Navy, asking that preliminary reports be made, offering suggestions for organization of the scientific work. In the case of our reports for Wilkes' voyage, copies have recently been secured for our files.

About 20 years later the government sent two expeditions to the west, both of which were accompanied by an Academy member, Dr. Samuel W. Woodhouse who went as official surgeon and naturalist. These were the Creek and Cherokee boundary survey in 1849-56 and the Zuni River Expedition in 1851. Much of the material from these expeditions came to the Academy and in the *Proceedings* Dr. Woodhouse and others described many of the new species involved.

Among other early government-sponsored expeditions and surveys which were accompanied by men whose names were then or later on the Academy membership rolls, may be listed the following: The Cass Expedition to the Great Lakes in 1820. The Long Expedition to the St. Peter's River in 1823. Schoolcraft's Expedition into the Indian Country in 1831. Schoolcraft and Allen's Expedition to the source of the Mississippi River in 1832. Featherstonehaugh's Survey of the Elevated Country between the Missouri and Red Rivers in 1834. Owen's Exploration of Iowa, Wisconsin and Illinois in 1839. Fremont's Expedition between the Missouri River and the Rocky Mountains in 1842, and Fremont's Expedition to Oregon and California in 1843. So far as known, none of the results of these expeditions were published in our serials.

Closely allied in character to these expeditions were the following enterprises. Our government at this time was making strong efforts to extend the knowledge of the unexplored and undeveloped portions of the West. Railroads were projected, boundaries were being settled and natural resources were being assessed. In the reports on the projects mentioned below, the government made use of the Academy's *Proceedings* and the second series of the *Journal* to publish reports on natural history findings. These enterprises follow those just mentioned, chronologically, and as a group occupied a period from the early 1850's to the late 70's. (1) The United States and Mexican Boundary Survey. (2) The Pacific Railroad Surveys. (3) The United States Astronomical Expedition to the Southern

Hemisphere. (4) Hayden's Early Explorations in the West. (5) Northwestern Boundary Survey. (6) The North Pacific Exploring Expedition. (7) Isthmus of Panama and Nicaraguan Surveys. (8) Page's Explorations in South America. (9) Hayes Arctic Explorations.

Individual Academy members continued to make their own private expeditions through the middle years of the century. Examples of these are the trip of Edward Horn to California in the early 1850's and the numerous journeys of John L. LeConte to Lake Superior and California and to Honduras, Panama, Europe, Egypt and Algiers in the 1840's and 1850's.

From 1880 to 1900 most of the expeditions from which the Academy received material were small private enterprises, though in the aggregate much was gained from them. However, the first expedition which the Academy officially sponsored came in this period—that to Yucatan and Mexico—headed by Angelo Heilprin in 1890. This was an important expedition and was reported upon in many *Proceedings* papers. Other expeditions in the 1890's which had Academy backing were the Peary West Greenland expedition in 1891 and that for the relief of Peary in 1892, which was in charge of Professor Heilprin.

At about the turn of the century or before, began a long series of small expeditions sponsored by the Academy and conducted by members of the scientific staff or other Academy members. These have been continued to the present time. They cannot be listed in detail, but include biological explorations into many lands and to all sections of the United States. Of special importance in this respect should be mentioned the many trips of James Bond, Stewardson Brown, P. P. Calvert, Judson Coxey, Rodolphe M. de Schauensee, Henry W. Fowler, Samuel G. Gordon, Morgan Hebard, Wharton Huber, Clarence Moore, Francis W. Pennell, Henry A. Pilsbry, James A. G. Rehn, S. N. Rhoads, Horace G. Richards, H. R. Roberts, Benjamin Sharp, Henry Skinner and Witmer Stone.

These expeditions, though small in number of personnel, are of great importance in results achieved, as they were conducted by trained scientists looking for specific material.

In recent years, particularly since 1930, the Academy has benefitted from a series of more elaborate expeditions whose primary object has been the acquisition of fine specimens for museum groups or comprehensive surveys in special areas. Again it is impossible to elaborate on these, or even attempt to list them all. However, typical examples may be found in the following list:

Harry Whitney to Alaska. The numerous expeditions of de Schauensee to Siam, Africa and Guatemala. Many expeditions of R. R. M. Carpenter and William K. Carpenter to Mexico, Africa and northwestern North America. George Vanderbilt's several expeditions to the West Indies, the

Galapagos, Hawaii, Sumatra and Africa. Expedition to Bermuda by Col. Edwin M. Chance. Mrs. Norman Henry's various journeys to British Columbia. Clement B. Newbold to British Columbia and Peru. The Dennison-Crockett South Pacific expedition. Prentiss Gray's African expedition. Legendre's Southwest Africa Expedition. Several expeditions to Asia, Mexico and Newfoundland by Brooke Dolan, II. Catherwood-Chaplin expedition to the West Indies.

When it is realized that the Academy has listed over 200 expeditions between 1922 and the beginning of the war in 1941, it will be realized that many important projects have been omitted from this list.

ANNOTATED LIST OF PUBLICATIONS OF THE ACADEMY

Serial Publications

1817. Journal of the Academy of natural sciences of Philadelphia. v. 1-8, 1817/18-1839/42. illus., plates (part colored), maps, diagrs. 22½ cm. & 24½ cm.

At a meeting of the Academy members on February 4, 1817, a committee was appointed to inquire into the expediency of publishing a periodical *Journal* of the Society. One month later the Committee reported in favor of issuing such a publication, and at the next meeting the report was adopted, "with a great deal of apprehension . . ." Thomas Say, the most zealous scientist of the group, expressed himself as not too confident of the success of the enterprise. However, work was immediately started and the first number of the new publication was placed before the meeting held on May 20, 1817, only a little over three months from the date of its first formal suggestion. In this simple and expeditious way was born the institution's first serial publication. In the introduction to the first volume, the members of the Academy are represented as, "desirous of contributing their share to the mass of knowledge, as early in all cases, and with as little show, and as small expense as possible." It is also of interest to note that in the second part of this volume the Publication Committee states that, "It is necessary further to observe, that the Society explicitly disavows any responsibility for the contents of the papers which are published, such responsibility resting entirely with the authors."

Difficulties soon developed with printing expenses. These resulted in the purchase of an old printing press on which most of the first volume was printed in Mr. Maclure's house, by Thomas Say, Thomas Nuttall and a few other members. The financial assistance of William Maclure and the scientific zeal of Thomas Say were two of the most important factors in keeping the publication alive in its early days. Considering the fact that the *Journal* contributed so much to the success and sound establishment of the Academy at this time, the strong support of these two gentlemen may even have been responsible for the actual survival of the Society.

The first volume of this serial was illustrated with 23 plates, all by C. A. Lesueur, who also contributed the first article. His plates gave artistic distinction to the first five volumes. Other good illustrations were contributed by Titian R. Peale, and the engraving of Alexander Lawson is notable. There has been much conflicting evidence printed on the subject of the first lithograph published in

America, but it is at least certain that Lesueur's first lithograph published in an early volume of this serial was one of the earliest.

Edward J. Nolan, for many years librarian, editor and scientist at the Academy, refers to the presentation of the first published number of the *Journal* as an event of much importance in the history of science in America and says further that, "there was no medium at that time in Philadelphia through which systematic scientific papers could be conveyed to the public."

By 1842 eight volumes of two parts each had been issued, containing contributions from nearly all the active naturalists of the period. The 52 contributors included many whose papers have become classic. Among these were Audubon and Bachman, Charles L. Bonaparte, T. A. Conrad, S. S. Haldeman, Isaac Lea, William Maclure, Samuel G. Morton, Thomas Nuttall, George Ord, Thomas Say, L. D. de Schweinitz, Gerard Troost, and Lardner Vanuxem.

The date of publication of the various parts of the *Journal* are noted on page vii of the 1913 Index to the Scientific Contents of the Journal and Proceedings.

The supplementary material appearing in the first series of the *Journal* is of minor importance. It consists of: (1) An act to incorporate the Academy and its constitution, vol. 1, pt. 4; vol. 6, pt. 2. (2) By-laws of the Academy, vol. 6, pt. 2. (3) A catalogue of the library, begun in pt. 1, vol. 1, and continued through pt, 2, vol. 2. (4) A list of donors to the library, appearing in the same issues which contained the catalogue. (5) A list of donations to the museum, irregularly printed in vols. 1-6. (6) List of apparatus presented to the Academy, vol. 1, pts. 1 & 2.

1824. Report of the transactions of the Academy of natural sciences of Philadelphia during the years 1824, 1825-26, 1927-28. Philadelphia, 1824?-1829. 3 nos. 22 cm.

Caption title only for 1824 report. Submitted by the recording secretary (William H. Keating); with an appendix, p. 19-20: List of lectures delivered before the Academy, 1824. Other reports submitted by S. G. Morton as recording secretary, and printed by S. W. Conrad. Report for 1825-1826 also contains list of lectures.

1841. Proceedings of the Academy of natural sciences of Philadelphia. v. 1-100, 1841-1948. Philadelphia, The Academy, 1843-1948. illus., plates (part col.), portraits, maps, tables, diagrams. 22½ cm. & 25 cm.

Publication of the *Proceedings* was begun 107 years ago in March, 1841. This represents a slight overlapping with the first series of the *Journal*. In fact, through some inadvertence, one short article in which a number of new species were described, appears both in the last volume of the *Journal* and the first volume of the *Proceedings*.

It was intended that this new serial should be issued annually and thus supply the urgent need of a vehicle of prompt publication of research for the increased number of workers. During the first fifteen years of its life, however, only seven volumes came out. Beginning with the eighth in 1856 the original design was fulfilled and since that date one has come from the press for each year. The volumes for 1857 to 1900 are unnumbered, being identified on the title page by dates only.

At the time this project was started the members of the Society met each week and the early volumes contain a more or less detailed report of the meetings. Interpolated in these proceedings are many brief notes, descriptions of species and accounts of experiments. In the first three volumes the "Donations to the Library," "Donations to the Museum" and the reports of the recording secretary are registered month by month. For the terminal annual meeting the election of officers, standing committees, and a list of the curators are recorded. However, in spite of the space occupied by non-technical matter, the first volume contains the description of over 200 new genera and species and numerous nontaxonomic scientific articles. It must soon have become apparent that this running mixture of business and science was wasteful of space, for in 1849 the supplementary matter was largely transferred to the back of the volume and the main body of the text reserved for scientific contributions.

Many workers not otherwise associated with the Academy, published quite extensively in the earlier volumes of the *Proceedings*. The U. S. government as well, made considerable use of its pages for the publication of the results of its expeditions and surveys.

It is not surprising that the civil war and its aftermath should adversely affect biological scientific research. This was true at the Academy, as many of its members joined the armed forces. In fact, it is interesting to note that all our country's wars have been reflected in our publications. The years immediately following each conflict have brought lean volumes.

It has been difficult to determine the size of issue of the *Proceedings* throughout its history. However, as far back as 1863 the Academy was printing 1000 copies each year. Of these, 230 were used for exchange purposes. Though various changes occurred in the years following, the same number was printed in 1910. Between that date and 1930 at least eight changes occurred, ranging from 1030 to 1725. The present issue, owing to changes of policy in distribution, is 1350 copies. Of these 1000 are reserved for exchanges with other institutions.

Though the information does not appear on the title-page, the volumes of this publication are divided into three series. These data appeared on the original inside back paper cover and are last listed for volume 90 (1938), as follows:

First series: 1841 to 1856 (8 volumes).
Second series: 1857 to 1870 (14 volumes).
Third series: 1871 to 1938 (68 volumes). The present volume brings the third series to 78.

The changes in character of supplementary matter in succeeding volumes form a partial history of the development of the institution. In some cases special items were also issued under separate cover and as such are listed in the bibliography. These supplementary items, as they appear in the regular volumes, are listed below.

Supplementary Material in the Proceedings

Volume 1 (1841-43). (a) Memoir of William Maclure. (b) Address on laying of cornerstone . . . May 25th, 1839. (c) List of members and correspondents since 1812.

Volume 3 (1846-47). Annual reports of curators, recording secretary and librarian begin. These continue to 1920, when they are found only in the Annual Reports, and after 1923 in the Year Book. Reports of curators discontinued after 1924.

Volume 4 (1848-49). Sections called "Donations to the Library" and "Donations to the Museum" condensed in back of volume. The first is carried to 1874 when it is changed to "Additions to the Library," and discontinued in 1893. The second carries over into Annual Report in 1920.

Volume 9 (1857). First listing of letters received by Secretary, with annotations on subject matter. In 1877 this changed to "Report of Corresponding Secretary," which appears only in Annual Reports after 1920.

Volume 10 (1858). Proceedings of Biological Department appear. These continued for three volumes only.

Volume 19 (1867). The first annual report of a Section of the Academy (Conchological). Discontinued in 1904; then replaced by report of curator of department of Mollusca.

Volume 20 (1868). First annual report of the trustees of Building Fund. Continued to 1871.

Volume 23 (1871). First report of Microscopical and Biological Section. Continued to 1924.

Volume 28 (1876). (a) First annual report of the president. This was carried for two years, discontinued, appeared again in the 1901 vol. and not thereafter. This item also issued in Annual Report for the same years as in the *Proceedings*. (b) First report of Botanical Section: continued to 1920 only.

Volume 29 (1877). First report of Mineralogical Section, which was changed in 1880 to Mineralogical and Geological Section: this continued to 1920 and transferred to Annual Report.

Volume 32 (1880). Treasurer's reports begin. Discontinued in 1893: continued in Annual Report.

Volume 33 (1881). Irregular reports of "Professors" of various departments begin. Professors replaced standing committees. In 1899 by-law changes abolished professorships.

Volume 35 (1883). Reports of curators of Wm. S. Vaux collection begin. Continued to 1920 and then published only in Annual Report and Year Book.

Volume 43 (1891). First report of Ornithological Section. Transferred to Annual Report in 1920 and discontinued in 1924.

Volume 44 (1892). Report of Jessup Fund: subsequently transferred to Treasurer's report.

Volume 48 (1896). First report of Anthropological Section. This appears for only two years.

Volume 53 (1901). Publications of the Academy of Natural Sciences of Philadelphia. This bibliography by Nolan is the only one previously published.

Volume 72 (1920). All reports of secretaries, curators, sections; Additions to Museum; list of Officers, Council, Committees, etc., dropped from *Proceedings* and published in Annual Report thereafter.

Volume 73 (1921). "Abstracts of Minutes of the Proceedings": continues until present.

Volume 75 (1923). Joseph Leidy Commemorative Meeting. Also issued separately.

Volume 78 (1926). Supplement consisting of "Synopsis of North American Diatomaceae," Part I, 228 p. (Separate pagination.)

Volume 79 (1927). Part II of same supplement, with index of both parts, pp. 229-582.

Volume 88 (1936). Twenty-second Hayden Memorial Geological Award. (Previously announced briefly in "Abstracts of Minutes" and in Annual Reports.) Continued in volumes 91, 96, and 97.

Volume 89 (1937). (a) Notice of fifth award of Joseph Leidy medal. (Previously in "Abstracts of Minutes.") Continued in volumes 92, 96, and 98. (b) Minutes of international symposium on early man.

1847. Journal of the Academy of Natural Sciences of Philadelphia. Second series. Philadelphia, 1847-1918. v. 1-16. illus., plates (part col.), maps. 34 cm.

In 4 parts except vols. 7 and 15 which were published complete. Index to years 1847-1910 is included in " An index to the Scientific Contents of the Journal and Proceedings of the Academy of Natural Sciences . . . 1913."

In 1847 a new series of the *Journal,* in quarto, was begun. Its larger size was designed especially to provide for more adequate illustrations than could be presented in the *Proceedings.* It also offered a more elaborate publication to exchange for similar serials. This series, like the first, was published at irregular periods, and was used as an outlet for larger monographic works than had previously emanated from the Academy. The first number of volume I was ready for distribution in December, 1847, and the 16th and last volume was issued from 1913 to 1918. Each volume, with the exception of the seventh and fifteenth was issued in four parts. The seventh consisted of a single monographic work and was published complete. The 15th volume is worthy of note as commemorating the hundredth anniversary of the founding of the Academy, and was issued complete though consisting of 2 parts. The second part is made up of twenty-two memorial papers by distinguished members and correspondents of the Academy.

This second series of the *Journal* is notable for its fine lithographic plates, many in full color. In this respect it was fortunate in entering the field when " drawing on stone " was reaching its peak of perfection. Many talented artists contributed to this series. A few illustrations in later parts of the work are engravings. In all, the 16 volumes contain 671 plates, an average of over 40 for each volume. There are many additional text-figures.

Several volumes or sections of this series were financed in part or in full by authors or other individuals interested in their publication. Among these important gifts were: (1) The numerous lithographs illustrating Lea's observations on the Unionidae and Melanidae, extending through several volumes, were contributed by the author. (2) The entire expense of the 7th volume (Leidy's Monograph of the extinct mammalian fauna of Dakota and Nebraska) was defrayed by Joseph Jeans and W. P. Wilstach. (3) The plates illustrating many ornithological papers by Cassin were furnished by Thomas B. Wilson. Some of these fine lithographs of nearly a hundred years ago, are still to be found in the publication stock of the Academy. (4) Dr. Clarence B. Moore's papers on his explorations of southern burial mounds, one of the better features of later volumes of the series, were paid for entirely by the author.

The second series of the *Journal* is altogether the most elaborate publication of the Academy. It is almost entirely free from various types of supplementary matter which appeared in the first series and in the *Proceedings.* " Extracts from Chap. IX of the By-Laws of the Academy in regard to the publication of the Journal," appears in volume I. A list of members, 1812-1848, was printed, apparently for insertion in the first volume, because it was the only list of members printed in quarto. It is not found in our bound volumes however. Volume VI was apparently printed without an index. Dates of publication of author's separates are found in all volumes except the first.

Isaac Lea privately published many of his contributions to this series of the *Journal* in a separate work of 13 smaller volumes, entitled, Observations on the Genus Unio. Some material in Lea's issues were also from the Transactions of the American Philosophical Society.

1868. Annual report of the Board of trustees of the building-fund of the Academy of natural sciences of Philadelphia to the contributors to the fund, January, 1868. Merrihew & son, printers. 12 p. 22½ cm.

—— 2d report, Jan., 1869. 8 p.
—— 3d report, Jan., 1870. 8 p.
—— 4th report, Jan., 1871. 7 p.
—— 5th report, Jan., 1872. Collins printer. 8 p.
—— 6th report, Jan., 1873. 13 p.
—— 7th report, Jan., 1874. 16 p.
—— 8th report, Jan., 1875. 24 p. Includes list of subscribers. Dec., 1865, till Dec. 31, 1874.
—— 9th report, Jan., 1876. 23 p. Includes current list of subscribers.
—— 10th report, Jan., 1877. 15 p.
—— 11th report, Jan., 1878. 13 p.

No reports published between 1878 and 1891.

—— [12th] report, Jan., 1891. Collins printing house. 20 p., 3 plates.

Includes list of members who have died since its foundation in 1812 (but no dates for decease).

—— [13th] report, Jan., 1892. 12 p., 3 plates.
—— [14th] report, Jan. 10, 1893. 10 p.

All reports were submitted by W. S. W. Ruschenberger, Chairman of the committee.

1877. Annual report [of] the Academy of natural sciences of Philadelphia for the year 1877 to 1922 inclusive, Philadelphia, 1877-1923. 39 nos. 23½ cm. & 26 cm.

Contains reports of secretaries, librarian, curators and sections: additions to library: in some years additions to museum. Most of these were also issued in the *Proceedings* until 1920. The president's report was carried for a few years, discontinued and published only in 1901 thereafter. The last three reports contain articles on explorations.

1890. Annual report of the Treasurer of the Academy of natural sciences of Philadelphia, 1890 to 1919. 30 nos. 23½ cm. & 25 cm.

Reports for 1901, 1903-1919 entitled: Summary of the accounts of George Vaux, jr., treasurer of the Academy of natural sciences of Philadelphia for the fiscal year ending November 30. . . . Published also in the *Proceedings* for the corresponding years.

1900. The Entomological student. v. 1, nos. 1-4, v. 2, nos. 1-4, April, 1900-May, 1901.* Philadelphia, Academy of natural sciences. illus. 27 cm. & 23 cm.

Editor: J. Chester Bradley. No more published. Vol. 2, published by The Students' entomological association, Academy of natural sciences, Philadelphia.

1913. An index to the scientific contents of the Journal and Proceedings of the Academy of natural sciences of Philadelphia, 1812-1912. Published in commemoration of the centenary of the Academy, March 21, 1912. xiv, 1419 p. 24½ cm.

Edited by Edward J. Nolan. Contains list of contributors and their titles. Covers the years 1817 to 1910. Also contains "Index to genera, species, etc. described or referred to," also "Dates of publication" of *Journal,* 1817-1845, and *Proceedings,* 1841-1870 (v. 22).

1922. Special publication no. 1-3. Philadelphia, 1922-1930. illus. 26 cm.

Contents.—1. The mineralogy of Pennsylvania, by Samuel G. Gordon. 1922. 255, iv p., front., illus.—2. Crystallographic tables for the determination of minerals, by Victor Goldschmidt and Samuel G. Gordon. 1928. 70 p.—3. Gabb's California cretaceous tertiary type Lamellibranchs, by Ralph B. Stewart. 1930. 314 p., 17 pls.

1924. Year book [of] the Academy of natural sciences of Philadelphia for the year ending November 30, 1923-1931. Philadelphia, 1924-1932. 9 nos. plates. 25½ cm.

Cover-titles, with half-titles. Includes "Explorations, Natural history museum, Sections, Public lectures, Library, Publications, Secretaries, Treasurer, Members." In the 1923 issue, "The year book which begins with the present volume, includes the annual reports formerly issued." The 1924 *Year Book* mentions that the new by-laws do not provide for "Sections" of the Academy and that they automatically pass out of existence. The series is continued as the Academy's Review.

1933. Review of 1932, 1933, 1934, 1935. Philadelphia, Academy of natural sciences, [1933-1936]. 4 nos. 23 × 10 cm. & 19 cm.

This is an abbreviated continuation of the *Year Book.* No more published.

1935. Monographs of the Academy of natural sciences of Philadelphia. Number 1-7, Philadelphia, 1935-45. (No. 3 in 2 vols. of 2 pts. each. Last pt. publ. in 1948.) Plates (part colored). 27 cm.

Comprises comprehensive studies in natural history, published at irregular intervals.

1936. Frontiers; a magazine of natural history. Vol. 1, no. 1, Oct., 1936, to v. 13, 1948. [Philadelphia, The Academy of natural sciences, 1936-1948.] illus., maps, portraits. 29½ cm.

Published in October, December, February, April and June of each year. Editor, 1936-1940, John H. Fulweiler, jr., Dec., 1940 to 1948, McCready Huston. A popular scientific magazine. Sent to members.

1939. Notulae Naturae of the Academy of natural sciences of Philadelphia. No. 1 to 209, May 17, 1939, to April 16, 1948. illus. 23 cm.

Contents and author index to nos. 1-100, 1939-1942, was published in 1943. Another for nos. 101-200, 1942-1947, issued in 1947.

1939. Guide to the museum, with pictures. 1939 to 1947. [Philadelphia, The Academy of Natural Sciences.] Cover-title, 26 p., plates. 15½ cm. × 23 cm.

A short history of the Academy is printed on back cover. The early homes of the Academy are figured and described on inside of the back cover. The first two issues contained floor plan of the museum inside the front cover. Later ones have list of the officers and trustees of the Academy in this space. Covers in color, recent ones picturing a *Brachiosaurus* in green on yellow background. Plates are printed on both sides of the page, with descriptive text included. New groups are pictured and described the year after being opened to the public.

Separate Publications

1817? Circular [small pamphlet to be addressed to captains and other voyagers, containing directions for collection and preservation of natural history specimens]. Caption title, 8 p. 15½ cm.

First publication of the Academy, only copy known to exist today is in the Boston public library. The Committee reported (Minutes, Feb 4, 1817) that 500 copies had been printed.

1818. Act of incorporation and constitution of the Academy of natural sciences of Philadelphia. Printed by Dennis Heartt. 12 p. 23½ cm.

The first edition was published in 1817 as part of the first number of the octavo *Journal*. Republished with By-laws in v. 6, 1829.

1828. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. Printed by J. R. A. Skerrett. 12 p. 23 cm.

Only copy located is in collection of the Library Company of Philadelphia.

1829. Circular [small undated pamphlet, issued by the "Corresponding secretary, under the direction of the Academy" containing an appeal to the public to collect specimens for the museum, with suggestions for their preservation], Hall of the Academy of natural sciences of Philadelphia. Caption title, 11 p. 15 cm.

Apparently a revision of the *Circular* published in 1817.

1830. Notice of the Academy of natural sciences of Philadelphia. By a member. Cover title,11 p. 21½ cm.

"Extracted from the American journal of science and arts, no. 1, vol. 19," p. 88-96.

1831. —— Second edition. Philadelphia, printed by Mifflin & Parry. 15 [1] p. 21½ cm.

1835. A biographical sketch of the late Thomas Say, esq., read before the Academy of natural sciences of Philadelphia, December 16, 1834, by Benjamin Horner Coates. . . . Published by order of the Academy. Philadelphia. Printed by W. P. Gibbons. 31 [1] p. 21 cm.

Includes "List of the papers and other works of Mr. Say so far as ascertained": p. 27-31.

1835. A memoir of the late Lewis David von Schweinitz, P.D., with a sketch of his scientific labours. Read before the Academy of natural sciences of Philadelphia, May 12th, 1835, by Walter R. Johnson. . . . Published by order of the Academy. Printed by William P. Gibbons. 38 [1] p. front. (portrait). 22 cm.

Appendix: p. 36-38. Full titles of Mr. Schweinitz' scientific publications. Includes also "Tabular view of the botanical works of Mr. Schweinitz . . . ," p. [39].

1836. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. iv, 8 p. 23½ cm.

This edition was bound with the *Catalogue of the library,* 1837, and apparently distributed with it.

1836. List of members and correspondents of the Academy of natural sciences of Philadelphia, from the origin of the Society on the 25th of January, 1812, to the 1st of November, 1836. 16 p. 24½ cm.

Most copies are bound in front of the *Catalogue of the library,* 1837, and apparently were distributed with it.

1836. Notice of the Academy of natural sciences of Philadelphia, with an appendix . . . third edition. Published by direction of the Academy, W. P. Gibbons, printer. 32 p. 21½ cm.

Appendix.—No. 1. List of resident members.—2. Chronological list of the officers, from its foundation to the 1st January, 1836.—3. Subscriptions toward the purchase of property.—4. List of 1834 subscribers to purchase glass cases.—5. Expenses of transporting the Maclurian library from New Harmony, Ind., defrayed by following subscriptions. (Also lists the number of books contained in that library.)—6. Legacies. Back cover carries request for donations of books to the library of the Academy.

1837. Catalogue of the library of the Academy of natural sciences of Philadelphia. J. Dobson, printer. x, 300 p. 23½ cm.

(The first catalogue of the library was begun in the *Journal,* no. 1, vol. 1, 1817, and continued in vols. 2, 3, & 4.) All copies which were seen are bound and contain two separate publications in front, i.e., *Act of incorporation,* 1836, and *List of members and correspondents,* 1836. "Donations to the Library" appeared in the *Proceedings,* 1841-1873. Continued as "Additions to the Library," 1874-1892.

1837. List of members and correspondents of the Academy of natural sciences of Philadelphia, from the origin of the Society on the 25th of January, 1812, to the 1st of November, 1837. Philadelphia, Rackliff & King, printers. 18 p. 22½ cm.

The only copy located is on the shelves of the Library Company of Philadelphia.

1837. Notice of the Academy of natural sciences of Philadelphia. Fourth edition. Rackliff & King, printers. 24 p. 21½ cm.

1839. Address delivered on laying the corner stone of the Academy of natural sciences of Philadelphia, May 25th, 1839, by Walter R. Johnson. Published by order of the Academy. P. G. Collins, printer. 8 p. 25½ cm.

Nolan states that it was issued also with the *Proceedings*, vol. 1, 1841-43, but it was not found in the Academy's copies.

1840. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. T. K. & P. G. Collins, printers. 12 p. 24 cm.

1841. List of members and correspondents of the Academy of natural sciences of Philadelphia, from the origin of the Society on the 25th of January, 1812, to the 1st of September, 1841. Printed by T. K. & P. G. Collins. 19 p. 24½ cm.

Issued also with the *Proceedings*, vol. 1, 1841-43.

1841. A memoir of William Maclure, esq., late president of the Academy of natural sciences of Philadelphia, by Samuel George Morton, one of the vice-presidents of the institution. Read July 1, 1841, and published by direction of the Academy. Printed by T. K. & P. G. Collins. 37 p. 1 leaf, portrait. 25 cm.

Issued also with the *Proceedings*, vol. 1, 1841-43. Includes list of Mr. Maclure's publications.

1844. —— Second edition. Philadelphia, Merrihew & Thompson, printers. 33 [1] p., portrait. 24½ cm.

1848? Catalogue of the Strigidae in the collection of the Academy of natural sciences of Philadelphia, by John Cassin (no date). [19] p. 23½ cm.

Issued also with the *Proceedings*, vol. 4, 1848-49.

1848? Catalogue of the Vulturidae in the collection of the Academy of natural sciences of Philadelphia, by John Cassin (no date). [7] p. 23½ cm.

Issued also with the *Proceedings*, vol. 4, 1848-49.

1848. List of members and correspondents of the Academy of natural sciences of Philadelphia, from the origin of the Society in 1812 to October 1, 1848. 1 leaf, 8 p. 32½ cm.

Apparently published to appear with the *Journal*, 2d ser., vol. 1, since it is the only *List of members* printed in quarto. The next published list of members was included in Ruschenberger's *A Notice of the origin and progress* . . . 1852.

1849. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. Merrihew & Thompson, printers. 12 p. 22½ cm.

1851. Catalogue of the Caprimulgidae in the collection of the Academy of natural sciences of Philadelphia, by John Cassin, November 1. [15] p. 23½ cm.

Issued also with the *Proceedings*, vol. 5.

1851. A memoir of Samuel George Morton, M.D., late president of the Academy of natural sciences of Philadelphia. By Charles D. Meigs, M.D. Read November 6, 1851, and published by the Academy. T. K. & P. G. Collins. 48 p., portrait. 23½ cm.

Includes an appendix with bibliography.

1851? [Notice of the death of Richard Cowling Taylor.] 8 unnumbered p. 23 cm.

From the *Proceedings*, vol. 5, 1851, p. 290-296.

1852. Catalogue of the Halcyonidae in the collection of the Academy of natural sciences of Philadelphia, by John Cassin, Nov. 1. [19] p. 23½ cm.

Issued also with the *Proceedings*, vol. 6.

1852. A notice of the origin, progress, and present condition of the Academy of natural sciences of Philadelphia, by W. S. W. Ruschenberger . . . (Read before the Society, February 10, 1852). Philadelphia, T. K. & P. G. Collins, printers. 78 p. 23 cm.

Contains " Members of the Academy, Dec. 31, 1851 " on p. 75-78.

1853. Catalogue of the Hirundinidae in the collection of the Academy of natural sciences of Philadelphia, by John Cassin, July 1, 1853. [15] p. 23½ cm.

Issued also with the *Proceedings*, vol. 6.

1853. Catalogue of the oological collection in the Academy of natural sciences of Philadelphia, by A. L. Heermann, M.D., March 1. [36] p. 23½ cm.

Issued also with the *Proceedings*, vol. 6.

1854. Discourse in commemoration of the founding of the Academy of natural sciences of Philadelphia, by William Parker Foulke. Delivered, March 20, 1854, in the Hall of the University of Pennsylvania. Printed for the Academy. 58 p. 24½ cm.

1856. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. C. Sherman & son, printers. 36 p. 21½ cm. (trimmed).

Contains " Members of the Academy of natural sciences of Philadelphia," p. 17-36.

1857. Act of incorporation, by-laws and list of members and correspondents of the Academy of natural sciences of Philadelphia. Merrihew & Thompson, printers. 38 p. 23½ cm.

1857. Catalogue of human crania, in the collection of the Academy of natural sciences of Philadelphia: Based upon the third edition of Dr. Morton's " Catalogue of skulls," etc., by J. Aitken Meigs, M.D., Librarian of the Academy of natural sciences of Philadelphia. 112 p. illus. 24½ cm.

Issued also with *Proceedings*, vol. 8, 1856.

1857. List of members and correspondents of the Academy of natural sciences of Philadelphia, from the origin of the Society in 1812 to March 1, 1857. 1 p.l., p. 17-38.

Issued also in "Act of incorporation," 1857. Members of the Academy were also listed in "Act of incorporation and by-laws," 1856, p. 17-36.

1858. Hints to craniographers upon the importance and feasibility of establishing some uniform system by which the collection and promulgation of craniological statistics and the exchange of duplicate crania may be promoted. From the *Proceedings* of the Academy of natural sciences of Philadelphia, August, 1858. Philadelphia, Merrihew & Thompson, printers. 8 p. 21 cm.

Certain paragraphs have been appended to the six-page article appearing in the *Proceedings*.

1859. Catalogue of the invertebrate fossils of the cretaceous formation of the United States, with references, by Wm. M. Gabb, September. 20 p. 23½ cm.

Issued also with the *Proceedings*, vol. 11.

1860. A notice of the origin, progress, and present condition of the Academy of natural sciences of Philadelphia, by W. S. W. Ruschenberger . . . (read before the Society, February 10, 1852). Second edition, revised and corrected up to January 1, 1860, by the author. Philadelphia, Collins, printer. 102 p. 23½ cm.

1861. Catalogue of the fishes of the eastern coast of North America, from Greenland to Georgia, by Theodore Gill, January. 63 p. 23½ cm.

Issued also with the *Proceedings*, vol. 13.

1862. Handbook to the museum of the Academy of natural sciences of Philadelphia. Ed. by J. H. Slack, M.D. Philadelphia. Printed for the Academy by Collins. viii, 116 p. 15½ cm.

1865? An address. [An appeal for pecuniary aid, Philadelphia.] Caption title, [4] p. 21½ cm.

1866. To sustain the appeal for pecuniary aid, April, 1866. [2] p. 24½ cm.

1866. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. Merrihew & son, printers. 24 p. 23 cm.

On title-page: "This proof copy embraces the proposed by-laws as they were submitted to the Academy, with amendments suggested by different members, as far as ascertained, January 16th, 1867. . . . Submitted by W. S. W. Ruschenberger, J. L. LeConte, Wm. S. Vaux, Isaac Hays, Robert Bridges, Committee."

1866. Handbook to the museum of the Academy of natural sciences of Philadelphia. Second edition. Ed. by J. H. Slack, M.D. Printed for the Academy by W. H. Yeakel. 130 p. 15½ cm.

1866. Observations upon the cranial forms of the American aborigines, based upon specimens contained in the collection of the Academy of natural sciences of Philadelphia, by J. Aitken Meigs, M.D. Merrihew & son, printers. Cover-title, 39 p. 22 cm.

From the *Proceedings*, May, 1866, p. 197-235.

1866. Report of the Committee to revise the by-laws. Philadelphia, Hall of the Academy of natural sciences of Philadelphia, October 30. 8 p. 23 cm. Caption title.

1868. A brief notice of the restored skeleton of the great herbivorous lizard Hadrosaurus, in the Museum of the Academy of natural sciences. Merrihew & son, printers. 12 p. 17½ cm.

1868. Members and correspondents of the Academy of natural sciences of Philadelphia, 1868. Printed for the Academy. Cover-title, 27 p. 22 cm.

Issued also with the *Proceedings*, vol. 21, 1870.

1868. Remarks of Mr. John Welsh, Chairman of a Committee appointed by certain citizens of Philadelphia, addressed to a Special committee of the House of Representatives of Pennsylvania, composed of the members from the city of Philadelphia, to which was referred the Senate bill, giving permission to the Councils of Philadelphia, to authorize the erection on the Penn Squares, of buildings for the promotion of natural science, literature, the fine arts and the mechanic arts, February 26, 1868. Caption title. 7 p. 21½ cm.

Pamphlet bears no indication of publisher, but it was listed by Nolan in 1901 with the Academy's publications.

1869. By-laws of the Academy of natural sciences of Philadelphia, adopted May 25th, 1869. Merrihew & son, printers. 22 p. 23 cm.

Issued also with the *Proceedings*, vol. 22, 1870.

1869. Catalogue and price list of rare and valuable conchological works, presented to the "Conservator's fund" of the Conchological section of the Academy . . . and ordered to be sold for its benefit . . . Philadelphia. Cover-title, 10 p. 21½ cm.

Lists 208 items.

1870? —— Undated catalogue with date assigned by Nolan, listing same number of items, but the titles not at all the same in the two lists. 12 p. 21½ cm.

1871. An address. The claims of the Academy of natural sciences of Philadelphia to public favor. By W. S. W. Ruschenberger. Collins, printer. 32 p. 4 plates. 23½ cm.

Includes list of subscriptions paid to the building fund, to May 1, 1871, and List of publications on back cover.

1873. Addresses delivered on laying the corner-stone of an edifice for the Academy of natural sciences of Philadelphia, October 30, 1872. Philadelphia, Collins, printer.

Addresses by W. S. W. Ruschenberger, E. R. Beadle, J. Aitken Meigs, and Horatio C. Wood. Issued also with its *Proceedings*, vol. 24, 1872.

1876. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. Collins, printer. 24 p. 23½ cm.

1876. [An appeal for pecuniary aid, suggested by the International exhibition] August. [3] p. 21½ cm.

1876. Guide to the museum of the Academy of natural sciences of Philadelphia. Published by the Academy. 128 p. 23½ cm.

W. S. W. Ruschenberger and George W. Tryon are responsible for the preparation of this pamphlet. Contains a list of the Academy's publications on back cover.

1876. Report of the condition of the Academy of natural sciences of Philadelphia on moving into its new edifice, s.w. cor. of Race and Nineteenth sts., made to the contributors to its building-fund, April 28, 1876, by W. S. W. Ruschenberger. Collins, printer. 56 p. 22½ cm.

Includes list of subscribers to the building-fund, Dec., 1865, till Apr. 24, 1876.

1877. Members and correspondents of the Academy of natural sciences of Philadelphia. Printed for the Academy. 48 p. 23 cm.

"Officers of the Academy . . . [1812-1877], p. 41-48.

1877. Summary history of the Academy of natural sciences of Philadelphia. By W. S. W. Ruschenberger, M.D. p. 99-119. 23 cm.

Published also as part of *Guide to the museum*, 1876. No copy of the separate work was located.

1879. To the members [an appeal for pecuniary aid]. By the Committee appointed to raise a maintenance or working fund, Oct., 1879. Caption title, [4] p. 21½ cm.

1879. Report of Council on the proposition to alter Art. VIII, Chapter I, of the by-laws (Presented to the Academy October 28, 1879). Caption title, 12 p. 23 cm.

At head of title: "Preface." Gives reasons why the change would be injurious to the Academy if adopted.

1880. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. Wm. P. Kildare, printer. 24 p. 23 cm.

Academy's publications are listed on back cover.

1882. Catalogue of valuable illustrated books, from the Academy of natural sciences of Philadelphia, being all the art works and duplicate works on natural history . . . also rare and curious works in French, Spanish and English to be sold Tuesday and Wednesday afternoons, June 6th and 7th, 1882, at 3 o'clock, each day, in our book department, first floor . . . M. Thomas & sons, Auct'rs. Cover-title, 37 p. 21½ cm.

1884. A syllabus of the courses of lectures and laboratory study and work provided for students in the natural sciences. Printed by the committee of instruction [of the Academy of natural sciences of Philadelphia]. 23 p. 23½ cm.

1885. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. Wm. P. Kildare, printer. 24 p. 21½ cm.

List of the Academy's publications on back cover.

1885? To the Senate and House of Representatives of the State of Pennsylvania: The Committee appointed . . . to solicit aid from the State of Pennsylvania . . . Caption title, [3] p. 24½ cm.

Joseph Leidy, Chairman of committee.

1887. Descriptive catalogue and price list of conchological works of George W. Tryon, jr. . . . Philadelphia, Academy of natural sciences, 12 p. 23½ cm.

Reference copied from Library of Congress catalogue. No copy located elsewhere.

1887. Fresh water sponges, a monograph by Edward Potts, including "Diagnosis of European Spongillidae" by Prof. Franz Vejdovsky. Philadelphia, Academy of natural sciences. 1 p.l., iv, [157]-279 p. illus., plates V-XII. 24 cm.

Extract from *Proceedings*, vol. 39, 1887.

1888. A biographical notice of George W. Tryon, jr., Conservator of the Conchological section of the Academy of natural sciences of Philadelphia. Horace Binder, printer. 22 p. portrait. 22½ cm.

Includes "List of papers and books written by George W. Tryon, jr.," p. 17-22 From the *Proceedings*, Nov. 27, 1888.

1890. Academy of natural sciences of Philadelphia. [Short account of the history and present status of the Academy, with some remarks about the plans for a new building and its probable cost, n.d.] Cover-title, 11 p., 3 plates. 18 × 15½ cm.

Nolan assigns date of 1890 to this pamphlet and states further that it was "Issued in connection with application for an appropriation toward the completion of the building."

1890. Academy of natural sciences of Philadelphia. [Short appeal to the public for funds while at the same time stating that the Pennsylvania legislature had appropriated $50,000 toward the erection of a new building, n.p., n.d.) 4 p. 23½ cm.

Apparently designed to accompany the preceding pamphlet appealing to the legislature for funds, since it is usually laid in that 1890 ed.

1891. Address on the life and work of Joseph Leidy, M.D., President of the Academy of natural sciences; professor of anatomy, University of Pennsylvania [n.p., n.d.]. 8 p., front. 21 cm.

This was "published in Proc. A.N.S. for 1891 and in part presented at a memorial meeting of the Academy earlier that year" states Dr. J. Percy Moore.

1892. Address delivered on the occasion of the opening of the new lecture hall of the Academy of natural sciences of Philadelphia, February 22, 1892, by the Rev. Henry C. McCook . . . vice-president. Cover-title, 4 p. 24½ cm.

1893. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. P. C. Stockhausen, printer. 24 p. 23½ cm.

1893. Members and correspondents of the Academy of natural sciences of Philadelphia. November 1, 1893. Printed for the Academy. 62 p. 22½ cm.

This is the last cumulated list published. Officers of the Academy, from 1812 to 1893 listed p. 53-62. Hayden Memorial geological fund [announcement] inside back cover, with a list of the Academy's publications on outside back cover.

1895? The Academy of natural sciences of Philadelphia. [Short publicity pamphlet, possibly intended for an attempt to get funds for the building program, n.d.] Cover-title, 7 p. 18 × 15½ cm.

Marginal annotations. Nolan assigns the date of 1895 to this and considers it a revised edition of the 1890 pamphlet entitled "Academy of natural sciences," of 11 p.

1895. In memoriam, John Adam Ryder. Philadelphia, Published by the committee in charge, June, 1895. [4] 28 p., front. 23 cm.

Frontispiece a portrait of Ryder. Includes 6 addresses and account of meeting. Committee: E. D. Cope, representing American Philosophical Soc.; Amos P. Brown, rep. Academy of Nat. Sci.; J. Percy Moore, rep. U. S. Comm. of Fisheries; and P. P. Calvert, rep. Univ. of Penna.

1899. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. 23 p. 23½ cm.

1899? Catalogue of duplicate books and pamphlets from the library of the Academy of natural sciences of Philadelphia, offered for sale at the prices affixed. . . . Cover-title, 38 p. 21½ cm.

1903. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. 22 p. 23½ cm.

1909. A short history of the Academy of natural sciences of Philadelphia, by Edward J. Nolan, recording secretary and librarian. The Academy of natural sciences. 1 p.l., 38 p., 6 plates (including portraits), 24½ cm.

Portraits of Dixon, Maclure, Ruschenberger & Leidy. Commemorates Founders Week.

1912. Celebration of the Centenary of the foundation of the Academy of natural sciences of Philadelphia, 1812-1912. Caption title, [4] p. 23 cm.

Program and lists of committees.

1912. Proceedings of the meeting held March 19, 20, and 21, 1912, in commemoration of one hundredth anniversary of the founding of the Academy. Philadelphia, Published by the Academy. cliv p., front. 36 cm.

On cover: "From the *Journal* of the Academy of natural sciences of Philadelphia, volume 15. Second series, November 22d, 1912." Index was prepared especially for this part of the volume, whereas the index in vol. 15 covers the entire volume.

1915. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia. 22 p. 23½ cm.

1922. —— Later edition. 23 p. 23½ cm.

1923. The Joseph Leidy commemorative meeting, held in Philadelphia, December 6, 1923. 2 p.l., 87 p., portrait. 26 cm.

Under the auspices of: the Academy of natural sciences of Philadelphia, the American association of anatomists, the American entomological society, the American philosophical society, the American society of naturalists, Boston society of natural history, the College of physicians of Philadelphia, National academy of sciences, Smithsonian institution, Swarthmore college, University of Pennsylvania, Wagner free institute of science, the Wistar institute of anatomy and biology, Zoological society of Philadelphia.

1924. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia (as revised in 1924). 14 p. 23 cm.

1927. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia (as revised in 1924 and amended in 1927). 14 p. 23 cm.

1928? Map outlining the expeditions of the museum during the years 1927 and 1928. Academy of natural sciences.

Map is 28 × 41 cm. folded once. Printed matter on back of map.

1929. Act of incorporation and by-laws of the Academy of natural sciences of Philadelphia (as revised in 1929). 17 p. 23 cm.

1931? Expeditions of 1930. Academy of natural sciences of Philadelphia. 1 colored map, 30½ cm. × 45 cm. folded once.

Explanations included as insets on map.

1931. Two hundredth anniversary of the founding of the first botanic garden in the American colonies by John Bartram, June 5-6, 1931. Catalogue of exhibit. Academy of natural sciences of Philadelphia. [15] p., front. 23 cm.

1932? Expeditions of 1931. Academy of natural sciences of Philadelphia. 1 colored map, 30½ cm. × 45 cm. folded.

Explanations included as insets on map.

1935. Reference-list of botanical collections and guide to herbaria consulted . . . by Francis W. Pennell [Philadelphia]. Cover-title, p. 597-628. 27 cm.

Excerpt from "The Scrophulariaceae of eastern temperate North America." Monographs of the Academy of natural sciences of Philadelphia, No. 1.

1936? ". . . And the work will be completed." [Philadelphia.] Cover-title, 12 p., illus. 26 cm.

1936. Birds of the West Indies, by James Bond. . . . An account with full descriptions of all the birds known to occur or to have occurred on the West Indian Islands. Philadelphia, Academy of natural sciences. xxiv, 456 p., colored front., illus. 19½ cm.

1936. "An experience is worth ten thousand words"; a summary of an educational survey, by Arthur E. Newbold, jr. [Philadelphia, Academy of natural sciences.] 4 p. 29 cm.

1936? Frontiers. Philadelphia. 23, 1 p. illus. including portraits. 28½ cm.

A brochure on different phases of the Academy's activities, but stressing the "Educational development program."

1936. How you benefit from the natural sciences; an address delivered by Dr. Edwin Grant Conklin, president of the American association for the advancement of science, at the Academy of natural sciences of Philadelphia, May 25, 1936. 1 p.l., 11 [2] p. 18 cm.

1936. A meeting of members of the Academy of natural sciences and their friends to the number of over six hundred, January 16, 1936. 15 p. 25½ cm.

On cover: "Addresses made by: Effingham B. Morris, Dr. William Berryman Scott & Dr. James Bryant Conant."

1937? Discovery; science at work, by the managing director [Charles M. B. Cadwalader]. The Academy of natural sciences of Philadelphia. 20 p., illus., including portraits. 25½ cm.

Cover has a reproduction of the frontispiece from "Early man symposium," 1937.

1937? —— Treasurer's report for the year ending Dec. 31, 1936. Academy of natural sciences of Philadelphia. 1 leaf. 23 cm.

The leaf was laid in the preceding publication, with the following explanation: "The Pamphlet 'Discovery' reports on the work of the Academy for the past year. This treasurer's report completes that account."

1937. Early man as depicted by leading authorities at the International symposium, The Academy of natural sciences, Philadelphia, March, 1937. Edited by George Grant MacCurdy. . . . Introd. by John C. Merriam. . . . Philadelphia & New York, J. B. Lippincott company. 362 p., front., illus., plates. 23 cm.

"Copyright, 1937, by The Academy of natural sciences, Philadelphia."

1937. Early man news. May, 1937. [4] p., illus. 44 cm.

"Survey of editorial opinion appearing on the occasion of the Academy's 125th anniversary."

1937. The international symposium on early man, March 17, 18, 19, and 20, 1937. In celebration of the 125th anniversary of the founding of the Academy of natural sciences of Philadelphia, 1812-1937. [Philadelphia, Academy of natural sciences.] 8 p. 27 cm.

An announcement, with program.

1937? . . . Till his work is done. Philadelphia [The Academy of natural sciences]. Cover-title, [8] p. 20 cm.

1938. The Audubon hall of birds. The Academy of natural sciences of Philadelphia. 8 p., illus. 20 cm.

1938. A national exhibition of the works of John J. Audubon. Commemorating the hundredth anniversary of the publication of the elephant folio, The birds of America. April 26th-June 1st, 1938. Philadelphia, The Academy. 44 p., portrait, illus. 23½ cm.

Of the ten plates, two are portraits (Audubon and The Marquis de Lafayette), the others reproductions from Audubon's work.

1939. Museum lessons for the schools of Philadelphia and vicinity, season 1939-40. [Philadelphia.] 8 p. 23½ cm.

Members of the educational staff are listed on back cover.

1940. Check-list of birds of the West Indies, by James Bond . . . Philadelphia, Academy of Natural Sciences. xi, 184 p., fold. map. 23 cm.

1940. A museum at work. Charles M. B. Cadwalader. [Philadelphia, Academy of natural sciences.] Cover-title, 20 p., illus. 28 cm.

1941. Birds of Mt. Desert Island, Acadia national park, by Carroll S. Tyson and James Bond; illustrated with photographs by Maurice Sullivan and drawings by Earl Poole. Philadelphia, Academy of natural sciences. vii, 82 p., illus., plates, fold. map. 18 cm.

1942? The Audubon bird hall of the Academy of natural sciences of Philadelphia . . . A guide to the Hall and its history. 1 p.l., 20 p. 15½ cm.

Reproduction of Audubon's Passenger pigeon on title-page.

1945. Check-list of birds of the West Indies, by James Bond . . . Second edition. Academy of natural sciences of Philadelphia. xiii, 182 p. 23 cm.

1945. A flora of Chester county, Pennsylvania; with especial reference to the Flora cestrica of Dr. William Darlington. Philadelphia, Academy of natural sciences. 2 vols., colored front., illus. (part colored). 25 cm.

BIOLOGICAL AND MICROSCOPIC SECTION

1858. Proceedings of the Biological department of the Academy of natural sciences of Philadelphia, 1858, 1859, 1860.

Issued with the *Proceedings* of the same dates. Each year has its own index. No separate copy located.

1858. Regulations of the Biological department of the Academy of natural sciences of Philadelphia. Caption title, [3] p. 21 cm. (trimmed).

List of members included.

1858. Report of the Committee of the Academy, appointed to confer with a Committee of the Biological society, on a proposed junction of the two societies. [Philadelphia] Hall of the Academy. Caption title, 8 p. 24½ cm.

Includes a section entitled: On the creation and government of departments, p. 5-8. Also in the *Proceedings*, 1858, p. 15-18.

1868. Proceedings of the Biological and microscopical department, 1868, 1869, 1870, 1871. [Philadelphia.]

Issued with *Proceedings* of the Academy of corresponding dates. No separate copy located.

1869. Regulations of the Biological and microscopical department of the Academy of natural sciences of Philadelphia. W. H. Pile, printer. Cover-title, 12 p. 22½ cm.

Includes list of officers and members for 1869.

1877. By-laws of the Biological and microscopical section of the Academy of natural sciences of Philadelphia, with a list of members. Printed for the section. Cover-title, [14] p. 23 cm.

1888. By-laws of the Biological and microscopical section of the Academy of natural sciences of Philadelphia, with a list of members and contributors. Printed for the section. 13 p. 23½ cm.

Contains also By-laws of the Academy relating to sections.

1895. Resolutions on the deaths of Geo. A. Rex, M.D., and Prof. John A. Ryder, members of the section. [Philadelphia.] 2 p. 24 cm.

Reprinted from the minutes of the Academy, before which body the resolution was presented, February 12, 1895, and April 9, 1895, respectively.

1922. Contributions. No. 1, July 15, 1922. New and rare species of Diatomaceae, by Charles S. Boyer. [Philadelphia.] Cover-title, 17 p. incl. 4 plates. 25½ cm.

No more published.

Conchological Section

1865. American journal of conchology. Edited by George W. Tryon, jr.... v. 1-7, Feb., 1865, to May, 1872. Philadelphia, G. W. Tryon, Conchological section of the Academy of natural sciences of Philadelphia. 7 vols., illus., plates (part col.), portraits, tables. 23½ cm.

Vols. 1-2 only, published by Tryon, the remainder by the Conchological section. Only seven volumes issued.

1866? By-laws established for the government of the Conchological section of the Academy of natural sciences of Philadelphia. Caption title, 18 p. 23 cm.

1867. Catalogue and synonymy of the genera, species and varieties of recent Mollusca described prior to January 1st, 1867, with dates of publication, references to plates, and localities. Philadelphia, Conchological section of the Academy of natural sciences [etc., etc.], 1867-1870. 5 pts. of 325 p. 25 cm.

Also issued in the *American journal of conchology*. *Contents.*—1. Pholadacca, by G. W. Tryon, jr.; Solenidae & Macteridae, by T. A. Conrad.—2. Anatinidae, by T. A. Conrad; Saxicavidae, Myidae, Corbulidae, Tellinidae, Pandoridae, by P. P. Carpenter.—3. Corbiculadae, by Temple Prime.—4. Porcellanidae & Amphiperasidae, by S. R. Roberts.—5. Marginellidae, by John H. Redfield; Melanidae, by A. Brot.

1870. A monograph of the fresh-water univalve mollusca of the United States. (In continuation of Prof. S. S. Haldeman's work, published under the above title) . . . by G. W. Tryon, jr. Philadelphia, Published by the Conchological section of the Academy of natural sciences [1870-71]. 238 p., 17 col. plates. 23 cm.

One copy has two sets of each of the 17 plates, one in color, the other black and white.

1877. Manual of conchology; structural and systematic. [Ser. 1] v. 1-17. Philadelphia, Published by G. W. Tryon; Conchological section of the Academy of natural sciences of Philadelphia, 1877-1898. Colored plates. 23 cm.

Beginning with v. 10, part 2, this series bequeathed to the Conchological section of the Academy, which published the remainder of the series under the editorship of H. A. Pilsbry. Vol. 17 carries an index to the families, genera and subgenera of vols. 2 to 17.

1885. Manual of conchology; structural and systematic. Ser. 2, v. 1-28. Philadelphia, Geo. W. Tryon; Conchological section of the Academy of natural sciences, 1885-1935. Colored illus. 23 cm.

The first four volumes were edited and published by George W. Tryon. Beginning with v. 5, the series was published by the Conchological section under the editorship of H. A. Pilsbry. In a few instances, Dr. Pilsbry was assisted by Alpheus Hyatt and C. Montague Cooke. Indexes were issued in vol. 9 (for v. 2-9), in v. 14 (for v. 10-14), in v. 20 (for v. 16-20), in v. 23 (for v. 21-23), in v. 27 (for v. 24-27). Vols. 1 & 28 have independent indexes.

ENTOMOLOGICAL SECTION (AMERICAN ENTOMOLOGICAL SOCIETY)

1861. Proceedings of the Entomological society of Philadelphia. Printed by the Society. Vols. 1-6, 1861/63-1866/1867. Philadelphia. illus., plates (part col.). 22 cm.

No more published. (c.f. its *Transactions*, vol. 7, appd. p. 1.)

1862. Charter and by-laws of the Entomological society of Philadelphia. Printed for the Society. 11 p. 22½ cm.

Name changed in 1867 to the American entomological society.

1865. A Memoir of Thomas Bellerby Wilson, M.D., prepared in pursuance of a resolution of the Entomological society of Philadelphia, by a committee. [Philadelphia.] The American Entomological society. 1 p.l., 38 p. 22½ cm.

1865. The practical entomologist. Vols. 1-2, Oct. 30, 1865, to Aug.-Sept., 1867. Philadelphia, The Entomological society of Philadelphia. illus. 28 cm.

Consecutively numbered throughout. Nos. 1-5: "A monthly bulletin, published by the Entomological society of Philadelphia, for gratuitous distribution among farmers and agriculturists." Nos. 6-17: "Published by the Entomological society of Philadelphia, for the dissemination of valuable knowledge among agriculturists and horticulturists." Nos. 18-24: "Published by the American entomological society, for the dissemination of valuable knowledge among agriculturists and horticulturists."

1868. The butterflies of North America, by Wm. H. Edwards . . . [I]. Philadelphia, The American entomological society, 1868-72. 3 p.l., ii p., 50 col. plates. 29½ cm.

Descriptive letterpress. 154 pages. 9 unnumbered pages of notes. Contains Synopsis of North American Butterflies. v, 52 pp. Plates 23 & 29 were each repeated by a 2d printing unlike the 1st. Vols. 2-3 were published by Houghton, Mifflin and Company.

1868. Catalogue of works in the Library of the American entomological society. Philadelphia. Printed by the Society, January, 1868. 1 p.l., 32 pp. 26 cm.

Also published with its *Transactions*, vol. 1, 1867-68.

1868. Transactions of the American entomological society. Philadelphia, American entomological society, 1868-1948, vols. 1-74. illus., plates. 23½ cm.

Vols. 7-16 as *Transactions* of the American entomological society and *Proceedings* of the Entomological section of the Academy of natural sciences of Philadelphia. Issued quarterly.

1872. Synopsis of North American butterflies, by Wm. H. Edwards . . . Philadelphia, The American entomological society. v, 52 p. 29½ cm.

(With his The butterflies of North America, vol. 1.) Text reprinted Boston, Houghton, Osgood and company, 1879. "Authors and works quoted in Synopsis": p. iii-v.

1877. Catalogue of the Lepidoptera of America north of Mexico. Part I, Diurnals, by William H. Edwards. Philadelphia, American entomological society. 1 p.l., 68 p. 25½ cm.

1884. Revised catalogue of the diurnal Lepidoptera of America north of Mexico, by William H. Edwards, Philadelphia. From Transactions of the American entomological society. 95 p. 24 cm.

1885. List of the Coleoptera of America, north of Mexico, by Samuel Henshaw. Philadelphia, American entomological society. 2 p.l., 161 p. 24 cm.

Printed in double columns. 1st supplement, Brooklyn ent. soc., 1887. 2d suppl., Brooklyn ent. soc., 1889. 3d suppl., American entomological society, 1895. 2 p.l., 62 p. 24 cm.

1887. Synopsis of the families and genera of the Hymenoptera of America, north of Mexico, together with a catalogue of the described species, and bibliography. Compiled by E. T. Cresson. [Philadelphia.] Transactions, American entomological society, Supplementary volume. iv, 350 [1] p. 23½ cm.

No separate copy located.

1890. Entomological news. v. 1-59. Philadelphia, American entomological society, 1890-1948. illus., plates, portraits. 23½ cm.

Vols. 1-35 as Entomological news, and proceedings of the entomological section of the Academy of natural sciences of Philadelphia. Issued monthly except for July & August, 1890-1906; except for August & September, 1907 on. The "Entomological Literature" section, inaugurated in 1910 and appearing in each number, has made the News a standard reference work in current bibliography.

1891. List of the Lepidoptera of boreal America, by John B. Smith . . . assisted by Henry Skinner, C. H. Fernald, Geo. D. Hulst, C. V. Riley. Philadelphia, American entomological society, 1891. 124 pp. 24 cm.

1897. List of members, resident and corresponding, of the American entomological society of Philadelphia. Corrected to January 1, 1897. Cover-title, viii p. 24½ cm.

1898. A synonymic catalogue of the North American Rhopalocera, by Henry Skinner . . . Philadelphia. xvi, 99, xiv p. 23½ cm.

1900. The entomologists' directory, containing the names, addresses, special departments of study, etc. of those interested in the study of insect life in the United States and Canada. Compiled by Henry Skinner, Philadelphia [The American entomological society], March 1, 1900. 3 p.l., 84 p. 23 cm.

Includes List of entomological publications for sale by the American entomological society; p. 73-84. Mostly published by the Society.

1903. Check list of the Lepidoptera of boreal America, by John B. Smith, assisted by Henry Skinner, and W. D. Kearfott. Philadelphia, American entomological society. v, 136 p. 23 cm.

1904. Supplement to the entomologist's directory of 1900. Compiled by Henry Skinner. 25 p. 3 unnumbered p. 23 cm.

1907. Catalogue of the neuropteroid insects (except Odonata) of the United States, by Nathan Banks. Philadelphia, American entomological society. 53 p. 24 cm.

1909. Proceedings of the American entomological society, February 15, 1909. Fiftieth anniversary. [Philadelphia.] Cover-title, p. 237-240. 24½ cm.

By Henry Skinner, Secretary. Also in *Entomological news,* May, 1909, p. 237-240.

1910. Catalogue of the nearctic Hemiptera-Heteroptera by Nathan Banks. Philadelphia, American entomological society. 103, viii p. 23½ cm.

1911. A history of the American entomological society, Philadelphia, 1859-1909. Prepared by request of the society by E. T. Cresson, with an introduction by the Rev. Henry C. McCook. . . . Philadelphia [American entomological society]. 60 p., front., portraits. 23 cm.

Appendix, p. 47-60. Names and terms of the officers from the foundation, List of members, Act of incorporation.

1916. By-laws of the American Entomological society of Philadelphia, adopted at a meeting held June 12, 1916. 8 p. 24 cm.

1916. Memoirs of the American entomological society, Nos. 1-13. Philadelphia, Published by the American entomological society at the Academy of natural sciences of Philadelphia. 1916-1948. illus., plates. 27 cm.

1925. Charter and by-laws of the American entomological society. Philadelphia, Printed for the Society. 12 p. 23½ cm.

1930. List of members of the American entomological society, Philadelphia, 1930. Caption title, v-ix p. 24½ cm.

1932. Act of incorporation and by-laws of the American entomological society. As revised November 17, 1931. Philadelphia, Printed for the society. 12 p. 23½ cm.

1943. Keys to the anopheline mosquitoes of the world, with notes on their identification, distribution, biology and relation to malaria. Prepared for the Preventive medicine division, Office of the Surgeon general, U. S. Army, by Paul F. Russell, Lloyd E. Rozeboom and Alan Stone. Philadelphia, The American entomological society, The Academy of natural sciences of Philadelphia. 1 p.l., 152 p., illus. 23½ cm.

"References": p. 143-147.

1943. Mosquito Atlas. Part I-II, by Edward S. Ross and H. Radclyffe Roberts. Philadelphia. Publ. by The American entomological society, The Academy of natural sciences. illus. 24 cm.

Part I, The Nearctic Anopheles, important malaria vectors of the Americas, and Aedes aegypti, Culex quinquefasciatus. iv, 44 p. Part II, Eighteen Old World anophelines, important to Malaria. iv, 44 p. In all 73 species figured, each on a separate page, with descriptive letterpress.

MINERALOGICAL AND GEOLOGICAL SECTION

1877. Proceedings of the Mineralogical and geological section of the Academy of natural sciences of Philadelphia. No. 1-2, 1877/79, 1880/81. illus. 23½ cm.

Includes a list of the officers as well as list of all members prior to the date of publication. Issued also in the *Proceedings*, No. 1 in 1880, p. 241-329; no. 2, 1882, p. 36-68.

PRIVATE PUBLICATIONS OR REPRINTS OF ACADEMY MATERIAL

In the following list are a number of publications which technically are not Academy issues. They were printed for the most part by the authors themselves and are included here because of close Academy association. There are three types of these: (1) Reprints from our *Journal* or *Proceedings*. (2) Works read before the Academy and published by the author. (3) Works published by the author while he was a member of our staff, the research presumably done at the Academy on its material.

1832. Lea, Isaac. Observations on the genus, Unio, together with descriptions of new genera and species . . . Philadelphia, Printed by J. Kay, jun., & co. [etc.] 1832-[74]. 13 v. 293 pl. (part col.). 34 cm.

Portrait as front. to v. 6. Reprints of papers from the *Transactions* of Amer. Philos. Soc. and *Journal* of Academy, 2nd ser.

1848. Lea, Henry C. Catalogue of the tertiary Testaceae of the United States . . . Philadelphia, Merrihew & Thompson. 15 p. 22½ cm.

"Read before the Academy of natural sciences of Philadelphia, April 4, 1848." Printed in double columns.

1852? Lea, Isaac. On the genus Acostoea of d'Orbigny, a fresh-water Lamellibranchia.

In Tryon's list of Lea's works, p. 49, it is stated that this paper was issued separately in pamphlet form. From *Journal* of the Academy, 2d ser., v. 2, p. 125-131, 1852. No separate seen.

1854. Lea, Isaac. Rectification of Mr. T. A. Conrad's "Synopsis of the family Naiades of North America" published in the "Proceedings of the Academy of natural sciences of Philadelphia, February, 1853." Philadelphia, Merrihew & Thompson. 16 p. 22 cm.

From the *Proceedings*, Dec., 1854.

1872. —— New edition. Philadelphia, Collins. 45 p. 25 cm.

1857. Lea, Isaac. Descriptions of four new species of exotic Uniones [etc., etc.]. Philadelphia, Merrihew & Thompson. Cover-title, 24 p. 22½ cm.

Twelve papers extracted from the *Proceedings* of the Academy of natural sciences, 1856-57.

1858? Lea, Isaac. Descriptions of exotic genera and species of the family Unionidae.

In Tryon's list of Lea's works, p. 49, it is stated that this paper was issued separately in pamphlet form. From *Journal* of the Academy of natural sciences of Philadelphia, 2d ser., v. 3, p. 289-321, Feb., 1858, plates 21-33.

1858? Lea, Isaac. Descriptions of the embryonic forms of thirty-eight species of Unionidae.

Tryon states that this was issued separately by Lea. From the *Journal* of the Academy of natural sciences of Philadelphia, 2d ser., v. 4, p. 43-50, Dec., 1858, plate 5.

1859? Lea, Isaac. New Unionidae of the United States [& Continuation].

Issued separately in pamphlet form, according to Tryon. From *Journal* of the Academy, 2d ser., v. 4, p. 51-95, Dec., 1858; v. 4, p. 191-233, Sept., 1859, plates 6-20.

1860. Lea, Isaac. Descriptions of eight new species of Unionidae from Georgia [etc., etc.]. Philadelphia, Merrihew & Thompson. 24 p. 22½ cm.

"Extracts from the *Proceedings* of the Academy of natural sciences of Philadelphia, of papers by Isaac Lea" [1859-60]. 12 papers.

1860? Lea, Isaac. New Unionidae of the United States and northern Mexico.

"Issued separately in pamphlet form." From *Journal* of the Academy . . . 2d ser., v. 4, p. 327-374, Dec., 1860, plates 51-66.

1862. Lea, Isaac. Description of a new genus (Trypanostoma) of the family Melanidae, and of 45 new species [etc., etc.]. Philadelphia, Merrihew & Thompson. Cover-title, 29 p. 22½ cm.

Five papers extracted from the *Proceedings* of the Academy . . . 1862.

1862. Lea, Isaac. Remarks on the number of Unionidae [etc., etc.]. Philadelphia. Cover-title, 47 p. 22½ cm.

Twenty-four papers extracted from the *Proceedings* of the Academy of natural sciences . . . 1860-61.

1866. Lea, Isaac. Leaia Leidyi—Cypricardia Leidyi [etc., etc.]. Philadelphia, Merrihew & Thompson. . Cover-title, 32 p. 22½ cm.

Eighteen papers extracted from the *Proceedings* of the Academy . . . 1863-66.

1869? Lea Isaac. Descriptions of exotic Unionidae.

"Issued separately in pamphlet form." From *Journal* of the Academy of natural sciences of Philadelphia, 2d ser., v. 4, p. 235-273, March, 1869, plates 33-45.

1874. Lea, Isaac. Notes on microscopic crystals included in some minerals [etc., etc.]. Philadelphia, Collins. Cover-title, 24 p. Plate 9. 22½ cm. (trimmed).

Seven papers extracted from the *Proceedings* of the Academy of natural sciences . . . 1869-1873.

1889. McCook, Henry C. American spiders and their spinningwork. vol. 1-3. Published by the Author, Academy of natural sciences of Philadelphia, 1889-1893. illus.

Volume 2 issued 1890.

1937. Stone, Witmer. Bird studies at old Cape May. . . . [Philadelphia] The Delaware Valley ornithological club at the Academy of natural sciences. 2 v. illus., plates. 27 cm.

1861. Tryon, George W., jr. Publications of Isaac Lea on recent conchology. Extracted from A List of American writers on recent conchology . . . Philadelphia, Bryson's printing rooms. 13 p. 22½ cm.

1861. Tryon, George W. Contributions to conchology. New York, Baillière brothers [etc., etc.], 1861-1865. 3 v. plates. 23½ cm.

Contents of volumes 2-3 in large part reprints from the *Proceedings* of the Academy. Volume 1, List of American writers on recent conchology; with the titles of their memoirs and dates of publication.

1864. The complete writings of Constantine Smaltz Rafinesque, on recent & fossil conchology. Ed. by Wm. G. Binney, and George W. Tryon, Jr.

Members of the Academy of Natural Sciences of Philadelphia. New York, Bailliere brothers [etc., etc.]. 95, 7 p., pls. LXXX-LXXXII. 23 cm.

1866. Tryon, George W. A monograph of the terrestrial Mollusca inhabiting the United States. With illustrations of all the species. Philadelphia, Published by the author.

1873. Tryon, George W. American marine conchology or, Descriptions of the shells of the Atlantic coast of the United States from Maine to Florida. Philadelphia, Pub. by the author. 208 p. 44 plates. 22½ cm.

Plates in duplicate, one colored followed by a black and white lithograph. Said to be one of the rarest conchological works, because the edition was limited to 50 copies.

1882. Tryon, George W. Structural and systematic conchology; an introduction to the study of the Mollusca. Philadelphia, Pub. by the author, Academy of natural sciences, 1882-84. 3 vols. in 1. 140 plates. 22½ cm.

Plates printed on both sides of page and numbered continuously for the 3 vols. Thin paper. Folded map as frontispiece to vol. 1.

1882. Tryon, George W. Structural and systematic conchology; an introduction to the study of the Mollusca. Philadelphia, Pub. by the author, Academy of natural sciences, 1882-84. 3 vol. fold. map, colored plates. 23 cm.

Plates printed on one side of paper, in duplicate, one colored followed by a black and white. Whole work on thick paper. Issued in 3 separate volumes.

1889. Heilprin, Angelo. The Bermuda islands: a contribution to the physical history, and zoology of the Somers Archipelago. With an explanation of the structure of coral reefs. Researches undertaken under the auspices of the Academy of natural sciences of Philadelphia. Philadelphia, Published by the author, Academy of natural sciences. 5 p.l., 231 p. front., 17 plates. 24 cm.

With additions by J. P. McMurrich, H. A. Pilsbry, George Marx, P. R. Uhler, C. H. Bollman.

PROCEEDINGS
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THE LOCUST GENUS TANAOCERUS AS FOUND IN THE UNITED STATES, AND THE DESCRIPTION OF A RELATED NEW GENUS (ORTHOPTERA: ACRIDOIDEA)

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Historical summary

The genus *Tanaocerus* was erected by Bruner in 1906,[1] based on the species *T. koebelei*, then described from two female specimens taken in the Panamint Valley, California, in April by Koebele, when on the Death Valley Expedition of the United States Department of Agriculture. By original indication the type is in the United States National Museum, while the second or paratypic female, retained at the time of description by Bruner, later passed, with the other North American material of that scholar's collection, to the Hebard Collection, and is now the property of this Academy. Systematically Bruner placed *Tanaocerus* in the vicinity of the three North American genera then considered to belong to the Eremobiini of the Oedipodinae, i.e. *Brachystola*, *Tytthotyle* and *Phrynotettix*. Today we know the proper position of the three latter genera is in the subfamily Romaleinae,[2] but that of *Tanaocerus* has remained problematical.

In 1931 Mr. Hebard described a second species of *Tanaocerus* from Lower California, *T. rugosus*,[3] basing it on three adult females and one immature individual of that sex, all of which material is now in the Academy series. This species is very distinct, and readily separated from *T. koebelei* by the characters given by its describer, and needs no further consideration at this time.

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[1] Biol. Cent.-Amer., Orth., II, p. 191.

[2] See Roberts, Proc. Acad. Nat. Sci. Phila., XCIII, p. 239, (1941).

[3] Trans. Amer. Entom. Soc., LVII, p. 122, pl. XXII, fig. 3. [♀ ; Mesa top fifty-four miles southwest of El Marmol, Lower California (type locality); Santa Caterina (err. for Catarina) Beach, fifty-two miles west of El Marmol, Lower California.]

While the adult male of *Tanaocerus* remained unknown until 1942, Mr. Hebard and the author had taken numerous immature individuals of both sexes of the genus during summer field work, over a number of years, in the lower desert areas of southwestern Utah, northwestern Arizona, southern Nevada and southeastern California, and correspondents had also sent in a few adult females from the latter state. It was then evident to us that individuals are not adult in summer, and that adult males would only be encountered earlier in the year, all the known adult females having been taken in March or April. With this in mind my colleague Dr. H. Radclyffe Roberts spent several weeks in April, 1942, in areas of California and Nevada[4] where, on the basis of then available information, the genus occurred. As a result of his work we now possess in the Academy series adult material of both sexes of the genus, which amplifies very greatly our knowledge of *Tanaocerus*, and makes possible a critical study of its general morphology and relationship, with which Dr. Roberts is at present engaged.

The most striking, and for an acridid unusual, feature of *Tanaocerus*, and also of the related and here described *Mohavacris*, is the exceptional length of the antennae, the proportions of which are, to my knowledge, unmatched in any other acridid. While less elongate in the female sex than in the male, they are, however, of remarkable length in both sexes, and are similarly striking in immature individuals.

Recently in a small lot of Orthoptera sent for determination by my friend Dr. P. H. Timberlake, of the Citrus Experiment Station at Riverside, California, was a single adult male individual, from the southern border of the Mohave Desert, of a striking and undescribed genus related to but very distinct from *Tanaocerus*. This discovery is of very great interest, as the general area in which it was taken has had considerable attention from trained entomologists, and this discovery also affords new evidence that the orthopterous fauna of our southwestern deserts still holds striking unknown types. The characterization of this new genus led to the examination of all the available systematic, distributional and bionomic information on *Tanaocerus*, the results of whcih are summarized in the following pages.

All of the material reported in this paper is contained in the collection of the Academy.

I.—*The Genus Tanaocerus as found in the United States*

Aside from the typical material of *T. rugosus* Hebard, from Baja California, which as extralimital is not here discussed, there is now in the Academy series nearly one hundred adult representatives of both sexes of *Tanaocerus*, as well as over sixty immature individuals in several younger instars, all from the United States. Thirty localities in the states of California, Nevada, Utah and Arizona are represented by this aggregation, these roughly defining the greater part of the area of the generic distribution in the United States.

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[4] This piece of field investigation was made with the assistance of a grant-in-aid from the American Philosophical Society.

In view of Dr. Roberts' forthcoming study of certain aspects of the genus, drawn largely from the very important series which he secured in 1942, I am not discussing the broad relationships of *Tanaocerus*, or of the related *Mohavacris*, but at Dr. Roberts' request I am here recording his material and making use of the systematic, distributional and bionomic information it supplies. I am also placing on record certain material of the genus which has been in the Philadelphia series for a number of years, this in part personally collected in company with my late colleague Mr. Morgan Hebard.

TANAOCERUS Bruner

1906. *Tanaocerus* Bruner, Biol. Cent.-Amer., Orth., II, p. 191.

Genotype (by monotypy).—*T. koebelei* Bruner.

The genus includes two species, the very distinct *T. rugosus* Hebard of Baja California, Mexico,[5] and the genotype *T. koebelei*, so far known only from the United States, but with its range undoubtedly extending into Baja California, and possibly into extreme northwestern Sonora, Mexico. The present study is concerned only with *T. koebelei*, for which the published systematic and distributional information can now be amplified materially. A few months past our friend Dr. Ernest R. Tinkham published an interesting set of Orthoptera observations, which among other things placed on record a considerable amount of information on this very distinctive and anomalous species.[6] The discovery of the genus *Mohavacris*, and critical comparisons of it with *Tanaocerus* brought to my attention the previously unrecognized subspecies of *T. koebelei* here described, and made desirable the amplification of our knowledge of the systematics and distribution of the species indicated by the material now in the Academy collection, and by such notes as were made at the time the same material was secured.

Tanaocerus koebelei Bruner

1906. *Tanaocerus koebelei* Bruner, Biol. Cent.-Amer., Orth., II, p. 192. [♀; Panamint (by error Panament) Valley, California.]

Distribution.—Desert areas of southern Nevada, southwestern Utah, southern California and western Arizona. The range of this species is much more extensive northward and also to the northeast than as summarized by Tinkham. While nearly all the peripheral points from which it is known are represented solely by immature individuals, and therefore their subspecific status cannot be determined satisfactorily, all belong to one or the other of the components of *T. koebelei*, and therefore are of value in outlining the range of that species as a whole. The species is an inhabitant of a part of the Western Desert Tract as outlined by Mearns,[7] and to the north its range extends into Nevada as far as the vicinity of Mina [8] and the Pilot Mountains immediately to the east of that locality, in Mineral County, and to the west base of Belted Peak, in Nye County; to the northeastward it reaches at least as far as the west slopes of the Beaver Dam Mountains, in Washington County, extreme southwestern Utah, and also occurs in the adjacent Mohave County, Arizona. The eastern border of its distribution, as far as at present known, would be indicated chiefly by Tinkham's records of its occurrence at Willow Beach, Mohave County, Arizona, which is on the east side of the Colorado River in Black Canyon, about fifteen to twenty miles south of Boulder Dam, on the west side of the Colorado River at Needles, San Bernardino County, California, and in the Gila Mountains, twenty-five miles east of Yuma, Yuma County, Arizona, where Tinkham secured adults in late December, 1941. To the southward *koebelei* reaches at least to the immediate vicinity of the northern border of Baja California, while on the west it extends in California to Jacumba, San Diego County, into the San Jacinto Mountain area as high as Pinyon Park (4,000 feet) and also penetrates the San Gorgonio Pass as far as Cabazon, while into the western Mohave it reaches at least as far as Llano, Los Angeles County, to the junction of the Slate and Argus Ranges, Inyo County, and also northwestward to the Silver Canyon Trail, White Mountains, in the same county, which latter section with the Mina, Nevada area constitute the northwesternmost limits of the known distribution. How far south into Baja California *koebelei* extends remains to be determined.

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[5] See footnote 3.

[6] Amer. Midl. Nat., XXXVIII, pp. 143-145, (1947).

It is, apparently, exceedingly scarce or local in western Arizona, south of Needles, where I have looked unsuccessfully for the genus for a number of years, and as recently as the past summer, while Tinkham's field work in the same area indicates that when found there it is exceedingly local. It clearly does not penetrate Arizona any considerable distance to the eastward, as sufficient work has been done in that state to make this reasonably certain. I doubt that *koebelei* will be found much to the north of the points here given, as environmentally and climatically the country would seem unsuitable for its existence.

The vertical distribution of *T. koebelei* is considerable, much greater than previous information would indicate. From below sea-level in the

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[7] See Bull. U. S. Nat. Mus., No. 56, pp. 31-32, pl. II, (1907).

[8] Full data for these localities are given in the listing of specimens examined on a following page.

Salton depression the species occurs at localities ranging as high as 6,700 feet in south-central Nevada (west base of Belted Peak) and 8200 feet on the eastern border of Owen's Valley, California (Silver Canyon Trail, White Mountains).

As Tinkham has pointed out, and has long been evident to those familiar with *Tanaocerus* in nature, it occurs adult only in the Winter and Spring, and during the warmer part of the year is represented only by immature individuals. Immature material before me represents a period extending from August 3-4 (Needles, California) to September 15 (Wagon Pass and Jacumba, California), and again, largely associated with mature individuals, from March 8 (three miles south of Oasis, California) to April 14 (Pinyon Park, California). Tinkham reports immature material taken October 18-20. Adults before me represent dates extending from March 9 (Whitewater, California) to April 14 (Pinyon Park, California), while Tinkham secured an adult male and a number of adult females on December 27, and February 2 and 14.

From this evidence Tinkham's conclusion that the eggs hatch in late August or early September, and that the nymphs mature in late December or January and live until April, needs to be modified only to the extent that while nymphs are present as early as early August, some are still immature by mid-April, and also that the adults undoubtedly live considerably later than April, as on April 14 the majority of the females found at Pinyon Park, California, were immature, indicating a definitely longer life span, although we as yet have no specific evidence as to just how long this may be.

Bionomics.—Tinkham (vide supra) has stated that "*Franseria dumosa* is the preferred host plant over the entire range of the species". This hardly coincides with my experience, as *T. koebelei* extends into areas where areally and altitudinally *Franseria dumosa* does not occur[9] (i.e. Silver Canyon Trail in the White Mountains, the Mina district and that of Belted Peak). He also records it as feeding on *Hymenoclea salsola* and *Coleogyne ramosissima.*[9] Field observations made on the spot at localities where immature individuals were taken by Rehn and Hebard, note that it was also beaten from creosote bush (*Larrea divaricata*) and desert holly (*Atriplex hymenelytra*) and on more than one occasion noted on brittle bush (*Encelia farinosa*). In addition our observations record the occurrence of immature individuals on a variety of other species of plants, unnamed but described in the notes. In consequence *Tanaocerus* would appear to be less controlled in its occurrence in the immature condition by any one species, or group of species, of plants than Tinkham's comment would indicate. Thus, the information now available shows that it occurs in a relatively broad range of desert environments. The immature condition, as has already been noted by Tinkham, is exceedingly active and in consequence can usually be secured only by beating the vegetation in which it takes refuge. Rarely it has been taken attracted to light at night (west base of Belted Peak, Nevada). The adults on the other hand are definitely more terrestrial, the females almost sluggish in their movements.

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[9] According to Tidestrom ("Flora of Utah and Nevada", Contr. U.S. Nat. Herb., 25, (1925)) *Franseria dumosa* and *Hymenoclea salsola* inhabit the "Covillea belt," and *Coleogyne ramosissima* forms "dense colonies above the Covillea belt". In the Death Valley Expedition report (North Amer. Fauna, 7, (1893)) *Franseria dumosa* is given as occurring "almost invariably in company with *Larrea* [=*Covillea*] *tridentata*"; *Hymenoclea salsola* is stated to reach as high as 5500 feet near Mud Spring, Emigrant Valley, Nevada; and the range of *Coleogyne ramosissima* is summarised as "the Grayia belt just above the upper limit of the *Larrea* [=*Covillea*]; it belongs therefore to the upper division of the Lower Sonoran Zone", while the highest elevation given for it is 6200 feet on the eastern slope of the Sierra Nevada above Owen's Valley. Our 1919 field notes, now before me, show that *Tanaocerus* was taken on Silver Canyon Trail in the White Mountains (elevation 8200 feet) in the pinyon belt, which was said to have little of the usual juniper admixture, and to extend from 7700 to over 9500 feet along the trail.

The best information we possess on the actions of this species, drawn largely from the splendid series of the genus now before me, is contained in Dr. Roberts' notes, which, with his permission, I am here quoting in part. Of its occurrence in the Panamints he has written: "Saw only 1 male actually on a bush before disturbed, and I never beat a specimen out of a bush at random nor kicked one out. Also when disturbed they will try and hide among the stones. The ground on which they were found was quite smooth and [composed of] small shaly pebbles on gentle slopes, usually not found in the washes." The following comments were drawn from Panamint specimens of both sexes, some of which were placed in a cage for observation: "The long slender antennae are used a great deal and it would appear as though their eyesight was poor. The specimens appear to have just become adult (April 3) and a few juv. ♀ were taken. Many of the females were very teneral and no evidence of copulation was seen." On April 6, on the road to Charleston Park, Nevada, at elevations of from 2000 to 5000 feet, he found it in a marked variety of environments, reaching vertically from one predominatingly that of the creosote bush (*Larrea*), through that characterized by the tree yucca or Joshua tree (*Yucca brevifolia*) to the beginning of the juniper and pinyon belt, where he states he secured "only juv. ♀ and 1 ♂, saw 2 others. Could not see a ♂ at lower localities though in one general spot collected 7 ♀." At two miles east of Llano, Los Angeles County, California, on April 9, it was taken among scattered Joshua trees, creosote bush and other desert vegetation. The notes made April 12 as to the occurrence of *Tanaocerus* in the San Jacinto Mountains west of Indio, at an elevation of 3500 feet, state that on a fine clear morning following a quite chilly night and after a day with showers he "could find none before about 10 A.M., collected all day with [results of] but 1 ♂ and very very few ♀. They were found at widely scattered places, always on the ground though they often leaped to edge of bushes. The ♀ were large and full of eggs and easy to catch in hand when located. Watched 1 ♀ for about 20 minutes. It just sat on the fine gravel or coarse sand and turned about two times. When I moved the net over it, and actually lightly brushed it, it did not jump. Hoppers in cage seemed very sluggish during the day in the sun. When it was cooler around sunset they were much more active (cold enough to wear a heavy sweater)." Dr. Roberts' comments on the general conditions at this locality are: "Granitic boulders about but these were crumbling and forming large areas of coarse gravelly sand—vegetation rich and varied—juniper, spanish bayonet, a few sickly greasewood, four or five species of low scattered bushes, short grass under most of the bushes. Most likely location for *Tanaocerus* was on smooth bare spots of moderate size with grass under adjacent bushes. [The single] Male [taken] showed no attempt to copulate."

From these notes it is evident that the adults, and particularly the females, are more terrestrial in habits than are the nymphs. Also it is equally clear that the latter may be found in a broader variety of desert vegetation than was indicated by Tinkham.

Key to Subspecies of T. koebelei

As the male of typical *T. k. albatus* is as yet not available, this key is based solely on the female sex.

Surface as a whole more rugose, pronotum with numerous short rugulae and rounded tubercles. Fastigial disk narrower, appreciably excavate; eyes slightly less prominent. Median carina of pronotum moderately evident;[10] caudal margin of pronotal disk and of lateral lobes more decidedly multicrenulate. Cephalic and median limbs proportionately less robust; caudal femora less elongate. Base coloration in general darker. *koebelei koebelei* Bruner

Surface as a whole smoother and less rugose, pronotum with very few rugulae or tubercles and these much less evident. Fastigial disk broader, hardly at all excavate; eyes slightly more prominent. Median carina of pronotum less evident; caudal margin of pronotal disk and of lateral lobes less deeply multicrenulate. Cephalic and median limbs proportionately more robust; caudal femora more elongate. Base coloration in general distinctly paler. .... *koebelei albatus* new subspecies

Tanaocerus koebelei koebelei Bruner Figs. 1-5, 12-15.

Original material.—Of the two females from the Panamint Valley, California, on which *koebelei* was founded, I now have the second, or paratypic, one before me, it having been retained by Dr. Bruner, whose collection, later acquired by Mr. Hebard, was subsequently presented by the latter to the Academy. In the original description Bruner indicated as the type the other specimen, which was the property of the United States National Museum.

As the male sex of *T. koebelei*, and for that matter of the genus *Tanaocerus*, was until recently unknown, and has never been described, I am selecting and briefly describing the male sex from one secured in 1942 by my colleague Dr. H. R. Roberts. It is from a locality on the west slope of the Panamint Mountains immediately above the Panamint Valley, the type locality.

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[10] In females of *Tanaocerus* the median carina is, to a greater or lesser degree, finely divided in two longitudinally by a micro-sulcation. The comment made above refers to the carina as a whole.

Allotype.— ♂ ; four miles north of Wild Rose, Panamint Mountains, Inyo County, California. Elevation, 4,900 feet. April 3, 1942. (H. R. Roberts.) [Academy of Natural Sciences of Philadelphia.]

In general form the male sex shows but little resemblance to the female being much smaller, more slender with marked structural and proportional differences.

Size relatively small; form more slender than in the female, as a whole less compressed, apex of abdomen somewhat recurved; surface of genae, nota, pleura and most of the abdominal tergites with scattered low short rugulae or blunt tubercles.

Head as seen from dorsum with longitudinal axis slightly shorter than median length of pronotum (as 32 to 36), greatest breadth across eyes nearly 1.4 times the head length (as 44 to 32), width across genae, as seen in cephalic aspect, subequal to that across eye, seen in profile the occipital outline is strongly arcuate ascendant to the vertex, while the fastigial outline is sharply straight oblique declivent thence to the inter-antennal protuberance, which is roundly produced, also in profile, while the facial line ventrad is moderately straight retreating to the buccal region; fastigium as seen from dorsum roughly quadrate in outline measuring caudad to the interocular vertex, surface moderately excavate, passing cephalad into the sulcation of the pronotal costa, lateral margins strongly carinate, these cephalad continuous with those of the frontal costa, caudad continuing in a diminishing fashion about the internal border of eyes and each with a low subangulation at the vertex, width of interocular space at vertex slightly less than the transverse breadth of one of the eyes as seen from the dorsum (as 13 to 15); frontal costa as seen in cephalic aspect with portion dorsad and briefly ventrad of median ocellus narrow, compressed, deeply linear sulcate dorsad of ocellus with bordering margins lamellato-carinate, ventrad of this section represented by a single medio-vertical carina;[11] lateral facial carinae well developed, moderately diverging ventrad: eyes quite prominent, subglobose as seen from dorsum, in profile with basal outline broad ovate, greatest breadth equal to three-fourths of the vertical depth, the latter subequal to the greatest depth of the infra-ocular portion of the genae. Antennae slender, very elongate, nearly 1.5 times as long as the body, articles 26 in number, all distad of second distinctly longer than broad, and all of these exclusive of a few near apex from 3 to 4 times as long as broad, the articles very faintly flattened but not at all expanded.

Pronotum slightly longer than the longitudinal axis of the head, subsellate, but with dorsal line virtually straight as seen in profile, greatest breadth ventro-caudad across lateral lobes slightly greater than pronotal median length (as 50 to 47); cephalic margin of dorsum subtruncate with a

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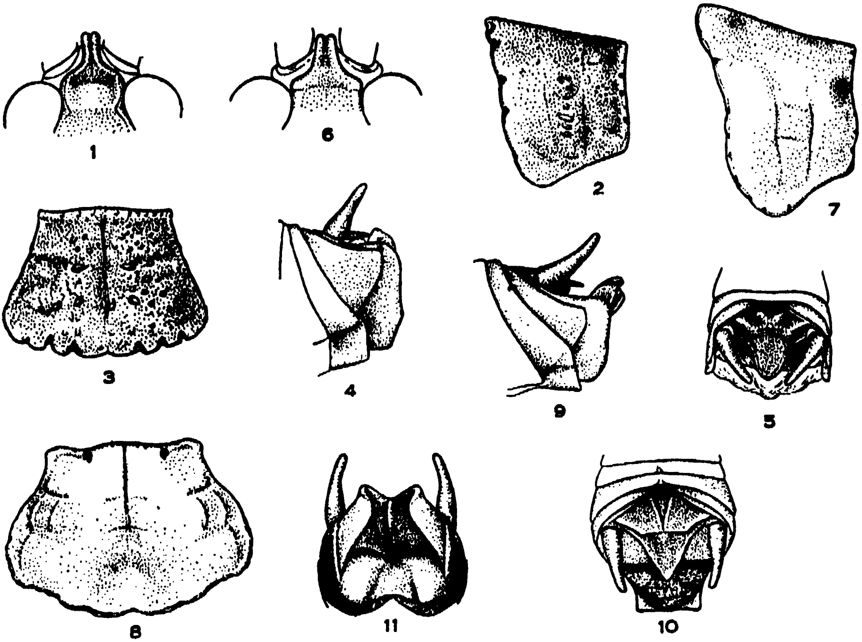
[11] The structure of this area is essentially as found in the genera *Teicophrys* Bruner and *Cadomastax* Rehn and Rehn of the Eumastacidae, and in members of the Tetrigidae.



Tanaocerus koebelei koebelei Bruner. Female (paratype). Panamint Valley, Inyo County, California. Fig. 1.—Dorsal view of fastigium (greatly enlarged). Fig. 2.—Lateral view of pronotum (× 5). Fig. 3.—Dorsal view of pronotum (× 5). Male (allotype). Four miles north of Wild Rose, Panamint Mountains, Inyo County, California. Fig. 4.—Lateral view of apex of abdomen (greatly enlarged). Fig. 5.—Dorsal view of apex of abdomen (greatly enlarged).

Tanaocerus koebelei albatus new subspecies. Female (type). Palm Canyon, Riverside County, California. Fig. 6.—Dorsal view of fastigium (greatly enlarged). Fig. 7.—Lateral view of pronotum (× 5). Fig. 8.—Dorsal view of pronotum (× 5).

Mohavacris timberlakei new genus and species. Male (type). Mohave Desert, San Bernardino County, California. Fig. 9.—Lateral view of apex of abdomen (greatly enlarged). Fig. 10.—Dorsal view of apex of abdomen (greatly enlarged). Fig. 11.—Caudal view of apex of abdomen (greatly enlarged).

very faint obtuse-angulate tendency, caudal margin of same truncate with several shallow crenulations and surface nodes spaced, median carina a distinct but low tectation and not an elevated ridge, not intersected transversely, surface of dorsum broadly rounded ventro-laterad into the lateral lobes, the latter deeper than long (ratio 40 in depth measured to medium carina and 32 long), cephalic margin of lobes vertical, nearly straight, ventro-cephalic angle narrowly rounded rectangulate, ventral margin sigmoid, caudal margin somewhat oblique, weakly sigmoid, ventro-caudal angle broadly rounded, surface of lobes with an intra-marginal cephalic transverse sulcus and a deeper, slightly premedian one which fails to reach the dorsal surface or the ventral margin of the lobe. Mesonotum and metanotum strongly tectate carinate, the former very narrowly exposed, caudal margin transversely subtruncate with a shallow median emargination; metanotum somewhat more broadly exposed than the mesonotum, its caudal margin as a whole broadly obtuse-angulate emarginate.

Prosternum bearing a transversely disposed oblong area which has a distinct and complete marginal raised cingulate rim, this marked off from a shallowly convex central area of the same general outline by an impression, which caudad is very deeply incised. Meso-metasterna subscutellate, with its greatest breadth, which is mesad, contained 1.25 times in its median length, encircling border of whole only vaguely and areally carinate, usually with no such tendency; mesosternal lobes very short, much broader than long, separated by an interspace somewhat greater than the width of a single lobe, internal margins of lobes obliquely diverging, passing into the equally straight oblique but laterally diverging caudal margins; metasternal foveolae closely placed, slit-like, oblique, divergent caudad, separated by a narrow septum, caudal margins of metasternal lobes straight and obliquely divergent caudad, broadly rounding laterad into the lateral margins of the meso-metasterna.

Abdomen compressed proximad, distad moderately enlarged and recurved subclavate, medio-dorsal carinate tectation well marked proximad; each of the distal dorsal tergites but narrowly evident, these telescoped by the recurvature of the abdominal extremity, in profile the ultimate tergite is seen to expand regularly ventrad, with its ventro-distal margin narrowly rounded rectangulate; supra-anal plate subtrigonal in outline, its proximal breadth and median length subequal, lateral margins weakly obtuse-angulate inbent at middle, apex narrowly rounded, surface medio-transversely with a shallow sinuate impression, this bordered proximad by a lateral pair of very low rugulae; cerci simple, styliform, tapering, erect, apices blunt acute, under relatively high magnification (× 40) seen to bear a number of minute low acute tubercles, in length the cerci are nearly equal to the median length of the whole supra-anal plate, and as viewed from the dorsum they are seen to incurve weakly distad, while in profile they are straight; subgenital plate divided into two lateral sections contiguous on the median line dorsad but with their internal margins diverging ventro-laterad so that a lower surface is exposed between, this whole area comprising the subgenital plate and the preceding sternite relatively soft and infolded;[12] ultimate sternite with disto-ventral margin markedly V-emarginate on median line, this making more evident the ventral aspect of the division of the two elements of the subgenital plate.

Cephalic and median limbs moderately robust, the femora of both pairs appreciably enlarging distad, cephalic femora approximately 1.3 times as long as the pronotum, the median ones slightly shorter, dorsal surface of each pair of femora with a low but stout medio-longitudinal carina dorso-cephalad, ventro-cephalic margin of each similarly carinate, each femur with cephalic genicular lobe larger and more expanded than caudal one; cephalic and median tibiae relatively stout, moderately compressed. Caudal femora but slightly shorter than the length of the body, extended caudad they reach distad of the abdominal apex a distance equal to twice the pronotal length, as seen from dorsum appreciably inflated, as seen in profile with depth at proximal third contained approximately 4.2 times in their length, medio-dorsal carina well elevated, ventral pair slightly lower and finer, other carinae evident but less sharply cut, pattern of external pagina composed principally of eight or so oblique, straight, spaced rugae, mediodorsal carina terminating distad in a very short spine, genicular lobes rounded distad; caudal tibiae subequal to the femora in length, with extensor surface subdeplanate and slightly broadening distad, margins with 12 external and 13 internal spines, spurs consisting of two pairs, both internal ones larger than the external, the extensor of each pair of somewhat larger size than the flexor; caudal tarsi in length equal to one-third that of the caudal tibiae, the proximal article comprising slightly more than two-fifths of the total tarsal length, that article appreciably deeper than the others, subtectate dorsad in distal two-thirds, distal article equal in length to seventeen-twentieths of that of the proximal one, arolium of moderate size, tarsal claws definitely surpassing the arolium, equal in length and development.

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[12] In consequence the majority of the adult males seen have this general area somewhat folded or telescoped, and its true form, in consequence, is hard to determine.

Color Notes.—The series of *T. k. koebelei* now before me show great variability in coloration, chiefly in general tone. This is totally unrelated to locality, and virtually all conditions will be found in material from a single one (i.e. four miles north of Wild Rose). In base tone the female sex ranges from light ochraceous-salmon mottled with cinnamon-brown on the body and ferruginous on the limbs, to an opposite extreme which is largely heavily mottled with olivaceous-black on a little evident light buff ground. In some females the pale base, which is little suffused ventrad, is dull hoary white or even buffy, and with the overlying dark suffusion less obliterative. In no case is the general tone as uniformly pale as in the available material of *T. k. albatus*. In the male sex the base tone ranges from cinnamon-buff to obscure olive-brown. The allotype has this ochraceous-buff. The antennal segments in both sexes, to a greater or lesser degree of evidence, are always alternately light and dark, while the dorsal surface of the caudal femora is obliquely trifasciate with a darker tone to a variable depth, the external face ventrad with remnants of a similar pattern, while the cephalic and median femora have a preapical and usually one or two more proximal dark annuli, all of variable depth, the cephalic and median tibiae possessing essentially similar annuli. In the female occasionally the abdominal dorsum bears in the middle of its length a more solid dark clouding. In the male sex there occurs infrequently a color phase with a pair of pale lines in the usual position of pronotal lateral carinae, these extending caudad at least to the distal margin of the mesonotum.

Measurements (in millimeters) of representative adult individuals

Typical *T. k. koebelei*

	Length of body	Length of antenna[13]	Length of pronotum	Length of caudal femur
♂, Amargosa Desert, 25 m. S. of Beatty, Nev.	8.8	12.7	2.	7.3
♂, Wild Rose Canyon, Panamint Mts., Cal.	8.6	13.7	2.2	7.
♂, 4 miles N. of Wild Rose, Panamint Mts., Cal., *allotype*	8.1	14.	1.7	7.3
♀, Amargosa Desert, 25 m. S. of Beatty, Nev.	21.	13.7	3.5	11.
♀, Daylight Pass, Nev.-Cal.	19.5[14]	10.7	3.4	9.5
♀, Road to Charleston Park, Charleston Mts., Nev.	21.	11.2	3.8	8.8
♀, 4 miles N. of Wild Rose, Panamint Mts., Cal.	17.5	12.	3.5	9.2
♀, Panamint Valley, Cal., *paratype*	23.[15]	12.2	3.4	10.4
Intermediate between *T. k. koebelei* and *T. k. albatus*				
♂, Pinyon Park, San Jacinto Mts., Cal.	8.8	15.9	1.9	7.6
♂, Pinyon Park, San Jacinto Mts., Cal.	8.9	15.6	1.8	7.8
♀, 2 m. E. of Llano, Cal.	16.6	14.1	3.5	10.5
♀, 2 m., E. of Llano, Cal.	21.8	12.3	4.3	10.2
♀, Pinyon Park, San Jacinto Mts., Cal.	17.4	12.5	3.7	10.9
♀, Pinyon Park, San Jacinto Mts., Cal.	18.5	12.3	4.	10.6

These measurements, which are fully representative, would seem to indicate that in the female sex at the higher elevations and in mountain localities, there is a reduction in the actual and relative length of the caudal femora when compared with that of the pronotum.

Distribution.—The material now available of the two subspecies of *koebelei* makes evident a pattern of subspecific intergradation and interdigitation quite similar to that of *Ligurotettix c. coquilletti* and *L. c. kunzei* in the same general areas, as pointed out in the latter connection by me nearly twenty-five years past.[16] Typical *koebelei* ranges in suitable environments over the greater part of the Amargosa and Mohave Deserts, Panamint Valley and adjacent mountain slopes and desert valleys northward, northeastward and westward to the limits which already have been discussed under the species. Southward it undoubtedly extends some distance into Baja California. In southern California it passes eastward into the here described *T. k. albatus* of the Colorado Desert. At 4000 feet elevation on the eastern slope of the San Jacinto Mountains (Pinyon Park) individuals are as a whole intermediate between the two subspecies, while somewhat lower down the same slope at 3500 feet they show by the general characters of the fastigium, pronotum, and limbs, as well as the very appreciably paler coloration, that they are definitely nearer *T. k. albatus*, and I am considering them atypical of that form. The Pinyon Park series of six adult females exhibits great plasticity and instability, with certain individuals virtually atypical of either form and others fully intermediate. Of three females taken two miles east of Llano, Los Angeles County, California, at an elevation of 2600 feet, in the southern part of the Mohave Desert, two are more nearly referable to *T. k. koebelei* and one is more nearly typical of *T. k. albatus*. A reference to the above mentioned paper apropos the intergradation of forms of *Ligurotettix coquilletti* will show that in the San Jacinto and related mountain masses that genus presents much the same degree of interdigitation found in *Tanaocerus*.

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[13] Only perfect antennae have been measured.

[14] Rather teneral.

[15] Abdomen somewhat extended abnormally.

[16] Trans. Amer. Entom. Soc., XLIX, pp. 61-62, 79, (1923).

For an analysis of available bionomic information reference is made to the preceding summary under the species.

Specimens examined: 96;[17] 22 ♂, 62 ♀, 12 juv. ♀.

Typical *T. k. koebelei*

NEVADA: Amargosa Desert 25 miles S. of Beatty, Nye County, elevation 2500 feet; IV, 5, 1942; (H. R. Roberts); 3 ♂, 3 ♀. Daylight Pass, Amargosa Range, between Nye County, Nevada and Inyo County, California, elevation 4500 feet; IV, 5, 1942; (H. R. Roberts); 6 ♀. Road to Charleston Park, Charleston (or Spring) Mountains, Clark County, elevation 3000-5000 feet; IV, 6, 1942; (H. R. Roberts); 15 ♀, 1 juv. ♀.

CALIFORNIA: Wild Rose Canyon Panamint Mountains, Inyo County, elevation 4500 feet; IV, 2, 1942; (H. R. Roberts); 4 ♂, 2 ♀, 3 juv. ♀. Four miles north of Wild Rose, Panamint Mountains, Inyo County, elevation 4900 feet; IV, 3, 1942; (H. R. Roberts); 8 ♂, 26 ♀, 1 juv. ♀. Panamint Valley; IV, 1891; (A. Koebele); 1 ♀ (*paratype*).

Intermediate between *T. k. koebelei* and *T. k. albatus*

CALIFORNIA: Two miles east of Llano, Los Angeles County, elevation 2600 feet; IV, 9, 1942; (H. R. Roberts); 3 ♀. Pinyon Park, San Jacinto Mountains, Riverside County; IV, 4, 1942; (H. R. Roberts); 8 ♂, 6 ♀, 7 juv. ♀.

Subspecies indeterminable, represented by juvenile individuals[18]

UTAH: Road canyon, west slope of Beaver Dam Mountains, Washington County, elevation 4100 feet; IX, 9, 1926; (R. & H.); 1 juv. ♀. Alluvial slope west of Beaver Dam Mountains, at state line, Washington County, elevation 2250 feet; IX, 9, 1926; (R. & H.); 1 juv. ♀.

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[17] In addition to this dry material Dr. Roberts collected certain alcoholic material for anatomical and similar study.

[18] This material is not included in the totals given above under "Specimens examined".

ARIZONA: West slope of Beaver Dam Mountains, Mohave County, elevation 2700 feet; IX, 7, 1926; (R. & H.); 1 juv. ♀.

NEVADA: Mina, Mineral County, elevation 4350-4850 feet; IX, 3, 1910; (R. & H.); 1 juv. ♀. Pilot Range, 3m. E. of Mina, Mineral County, elevation 4800-5700 feet; IX, 3, 1910; (R. & H.); 1 juv. ♀. West base of Belted Peak, Belted Range, Nye County, elevation 6700 feet; VIII, 25, 1924; (R. & H.); 1 juv. ♂. Beatty, Nye County; VIII, 9-12, 1919; (R. & H.); 1 juv. ♂, 1 juv. ♀. Bare Mountain east of Beatty, Nye County, elevation 4000 feet; VIII, 10, 1919; (R. & H.); 1 juv. ♀. Bullfrog Hills, Nye County; VIII, 11, 1919; (R. & H.); 1 juv. ♂, 1 juv. ♀. Lee Canyon, Charleston (or Spring) Mountains, elevation 4000 feet; VIII, 18-22, 1919; (R. & H.); 2 juv. ♂, 3 juv. ♀. Arden, Lincoln County; VIII, 9, 1907; (Hebard); 1 juv. ♂.

CALIFORNIA: Silver Canyon Trail, White Mountains, Inyo County, elevation 8200 feet; IX, 10, 1919; (R. & H.); 1 juv. ♀. Hole-in-the-Rock Spring, Boundary Canyon, Amargosa Range, Inyo County, elevation 2500-2900 feet; VIII, 13, 16 and 17, 1919; (R. & H.); 2 juv. ♂, 9 juv. ♀. Wild Rose Canyon, Panamint Range, Inyo County, elevation 4500 feet; (R. & H.); IX, 6, 1922; 1 juv. ♂. Spring in Wild Rose Canyon, Panamint Range, Inyo County, elevation 3617 feet; IX, 6 and 8, 1922; (R. & H.); 1 juv. ♀. Panamint Valley at mouth of Wild Rose Canyon, elevation 300 feet; IX, 6, 1922; (R. & H.); 1 juv. ♀. Panamint Valley opposite Hall Canyon, Inyo County, elevation 1500 feet; IX, 6, 1922; (R. & H.); 1 juv. ♀. Junction of Slate and Argus Ranges, Inyo County, elevation 2750 feet; IX, 8, 1922; (R. & H.); 1 juv. ♂, 1 juv. ♀. Barstow, San Bernardino County, VIII, 7, 1919; (R. & H.); 1 juv. ♂, 3 juv. ♀. Newberry, San Bernardino County, elevation 1831 feet; IX, 9, 1924; (R. & H.); 1 juv. ♂. Bagdad, San Bernardino County, elevation 750 feet; VIII, 6, 1919; (R. & H.); 2 juv. ♀. Needles, San Bernardino County; VIII, 3-4, 1919; (R. & H.); 4 juv. ♀. Twenty miles east of Desert Center, Riverside County, elevation 640 feet; VIII, 21, 1937; (Rehn, Pate and Rehn); 1 juv. ♂. Cabezon, Riverside County, elevation 1700 feet; VIII, 20, 1937; (Rehn, Pate and Rehn); 1 juv. ♀. Wagon Pass, 8 miles east of Jacumba, San Diego County, elevation 3700 feet; IX, 15, 1922; (R. & H.); 1 juv. ♀. Jacumba, San Diego County, elevation 2800 feet; IX, 15, 1922; (R. & H.); 2 juv. ♀.

Tanaocerus koebelei albatus[19] new subspecies Figs. 6-8, 16

Type.— ♀; Palm Canyon, Riverside County, California.[20] April 4, 1925.

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[19] Albatus, i.e., *clothed in white*, in allusion to the general whitish tone of this subspecies, when contrasted with the darker ones of *T. k. koebelei*.

[20] The elevation of Palm Canyon at its mouth, where it joins the broad expanse of the western Colorado Desert, is 500 feet above sea-level, and from this point the canyon ascends the eastern face of the San Jacinto Mountains to approximately 4500 feet at Vandeventer Flat.

(P. H. Timberlake.) [Academy of Natural Sciences of Philadelphia, Type no. 5752.]

Differing in the female sex from typical *T. k. koebelei* Bruner, of the Amargosa Desert, the Panamint, Amargosa and Charleston (or Spring) Mountain ranges, in its whole surface being definitely less rugose, the fastigial disk proportionately broader and hardly at all excavate, the eyes slightly more prominent, the caudal margin of the disk and of the lateral lobes of the pronotum less deeply multicrenulate, the median carina of the pronotal disk less pronounced, the cephalic and median limbs more robust, the caudal femora more elongate, and the base coloration generally paler, with its darker pattern more sharply contrasted. As very little male material, which could on geographic grounds be assigned to *T. k. albatus*, is available, and in this differential features of sexual character are not clearly evident, I am refraining from discussing at this time any male diagnostic features.

Description.[21]—General bulk very similar to that of *T. k. koebelei;* surface definitely smoother and less rugulose. Head with eyes slightly more prominent as seen in both dorsal and cephalic aspects, in basal outline as seen in profile broader ovate and less elliptical;[22] fastigium as seen from dorsum definitely broader than one of the eyes,[23] its surface almost plane and not distinctly excavate as in *T. k. koebelei.* Pronotum more smoothly and broadly cucullate than in *T. k. koebelei,* median carina indicated only as a very low medially finely sulcate carinula, distinctly less conspicuous than in *T. k. koebelei,* the general pronotal surface lacking the numerous short rugulae and rounded tubercles seen in *T. k. koebelei,* caudal margin of pronotal disk and lateral lobes crenulate as in *T. k. koebelei,* but not definitely accompanied by rounded tubercles as in that form. Mesonotum and metanotum with their caudal margins with two or three pairs of tubercles as in *T. k. koebelei,* but these are less pronounced, thickly strumose and the surfaces otherwise are much smoother and not rugulose. Cephalic and median limbs proportionately heavier, the femora thicker distad as seen in both dorsal and lateral views; caudal femora proportionately longer, more attenuate distad and with proximal section less robust in proportion to length of whole femur.[24]

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[21] The comparative elements of this description have been drawn from direct comparison with the previously mentioned paratype of *T. k. koebelei* and female individuals of the same subspecies from a number of the localities represented.

[22] The ratio of width to depth in the type is 27 to 29; in the Whitewater paratype 25 to 29. The paratype of *k. koebelei* shows 23 to 27, and a series of proportionate measurements of other females of that subspecies show this general ratio is maintained with only occasional deviation.

[23] In the type the breadth of the fastigium between the eyes as compared with the breadth of one of the eyes is as 23 to 21; in representative material of *T. k. koebelei* the two dimensions are approximately equal.

[24] The ratio of greatest depth of caudal femur in length of same is 4. in the type, while in material of *k. koebelei* the ratio varies in measured individuals to as low as 3.4, being 3.7 in the paratype.

Coloration.—General base color ranging from dull creamy white through cream-buff and pinkish buff to pale citron yellow,[25] overlaid by a pattern of well marked maculae of mummy brown to fuscous as follows: regular dark annulation of the antennae, usually but not entirely of alternate segments, and much more conspicuous than in *T. k. koebelei* in which the same pattern is indicated to a much less evident degree; brief postocular bars of variable emphasis extending caudad over not more than one-fourth of the pronotal length; regular punctate ticking of the cephalic and caudal pronotal margins, and less frequently of the ventral as well, on the caudal generally marking the marginal crenulations;[26] a pronounced dark blotch mesad on the mesonotum and another mesad on the abdominal dorsum, the latter generally involving two, but occasionally as many as four, tergites; occasionally another maculation is present immediately proximad of the supra-anal plate; pleura usually dark maculate, these also involving the sides of the proximal abdominal tergite; cephalic and median femora and tibiae with two or three (median femora) more or less complete annuli, those of tibiae broader than the femoral ones; caudal femora with three incomplete annuli, these obsolete on ventral face, and mesad on the external pagina where they are pronounced only dorsad and ventrad, marked as seen from dorsum with their trend obliquely disto-mesad; caudal tibiae with numerous darker clouds. Eyes ranging in tone from ochraceous-buff to cinnamon.

Measurements (in millimeters) [27]

Typical *T. k. albatus*

	Length of body	Length of antenna	Length of pronotum	Length of caudal femur
♀, Palm Canyon, California, *type*	19.4	15.4	4.	12.5
♀, Whitewater, California, *paratype*	16.0[28]	12.5	3.6	11.
Atypical *T. k. albatus*				
♀, San Jacinto Mts. west of Indio, California	17.4	13.3	3.4	10.6
♀, San Jacinto Mts. west of Indio, California	20.5	13.3	3.5	10.2
♂, San Jacinto Mts. west of Indio, California	8.1	15.6	1.8	7.8

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[25] The type is of the latter shade, faintly washed on the dorsum of the pronotum with lumiere green. The paratype has the base color much altered by desiccation, as is also true of the immature Oasis specimen. The series from the San Jacinto Mountains west of Indio show in their entirety the pale base coloration. This is very conspicuous when compared with the ferruginous to nearly fuscous base tone of females of typical *T. k. koebelei*.

[26] This element of the pattern is also present in *T. k. koebelei*, but of much less apparent emphasis, on account of the darker base color and the mottling of the numerous surface rugulae.

[27] In the case of localities represented by series these measurements are of the extremes of the respective sexes.

[28] Abdomen somewhat retracted.

Paratype.—I am considering as a paratype a single female specimen in the Academy series, taken at Whitewater, Riverside County, California, March 9, 1930, by C. M. Dammers.

Remarks.—I have not attempted to assign subspecifically the numerous quite immature individuals of *T. koebelei* before me, certain of which doubtless represent *T. k. albatus.* All have been listed on a preceding page under *T. k. koebelei.*

Specimens examined: 11: 1 ♂, 9 ♀, 1 juv. ♀.

California: Palm Canyon, Riverside County; IV, 4, 1925; (P. H. Timberlake); 1 ♀, (*type*); [A.N.S.P.]. Whitewater, Riverside County; III, 9, 1930; (C. M. Dammers); 1 (*paratype*); [A.N.S.P.]. Three miles south of Oasis; III, 8, 1936; (P. H. Timberlake; " in top of small bush "); 1 juv. ♀ (instar preceding maturity); [A.N.S.P.].

Atypical *T. koebelei albatus*

California: San Jacinto Mountains west of Indio, elevation 3500 feet; IV, 12, 1942; (H. R. Roberts); 1 ♂, 7 ♀; [A.N.S.P.].

II.—*Description of a New Genus related to Tanaocerus*

MOHAVACRIS[29] new genus

More nearly related to *Tanaocerus* than to any other genus known at this time, but readily separable by numerous features, the more striking of which are: the more elongate form; the more asperous condition of the body surface; the even longer antennae, which in the male sex are somewhat more than twice as long as the body, the proximal article of the same in that sex as seen from the dorsum being twice as long as its distal breadth, instead of subequal as in *Tanaocerus;* in the presence of definitely marked dorsolateral carinae continuously from the postocular region to the proximal abdominal tergites, and less clearly indicated thence to the abdominal apex; the pronounced elevation of the caudal section of the pronotal median carina and caudal margin into a vertical fin-like lobe; the tripartite male subgenital plate; and the much more elongate and attenuate limbs, the caudal femora being subequal in length to the whole body, rather than appreciably shorter than the same as in the male of *Tanaocerus.* As the male sex alone is known of *Mohavacris* these comparative features have been drawn solely from it.

Generic features.—(Male sex alone known.) Apterous. Form slender, subcompressed; body surface relatively asperous. Fastigial lateral margins sublobate at vertex, fastigial disk excavate; frontal costa dorsad of median ocellus strongly compressed and with lateral margins lamellate and contiguous, in profile subrectangularly produced between antennal bases, ventrad of median ocellus consisting of a single vertical carina, lateral facial carinae marked; eyes prominent; antennae exceedingly elongate and slender, over twice as long as body, composed of 27 articles, proximal one large, subdeplanate and twice as long as its distal breadth, second article smaller than proximal one, remaining articles very slender and attenuate, eumastacoid node on distal article. Pronotum sellate, with distinct lateral carinae which extend from the eyes to and on abdominal tergites, median pronotal carina elevated dorso-caudad into a rudder-like lobe, which also involves the median portion of the margin of the pronotal disk; lateral lobes subrectangulate, longer than deep. Prosternum transverse, elliptical, with encircling margins cingulately elevated, disk shallowly convex with paired foveolae placed caudo-laterad; meso-metasterna scutellate, mesosternal lobes widely separated by a transversely rectangulate interspace, metasternum with foveolae disposed transversely, no evident metasternal lobes present. Abdomen with a pronounced median carina; male supra-anal plate trigonal; male cerci simple, styliform, tapering; male subgenital plate tripartite, consisting of a pair of narrow lateral structures, between which is a median section bearing a medio-vertical lamellate ridge, which terminates dorsad at the emarginate dorso-distal margin. Limbs slender and attenuate; cephalic and median femora carinate; caudal femora subequal in length to the entire body, carinae well developed, pattern of external pagina with its oblique elements markedly carinate; caudal tibiae with marginal spination and distal spurs of normal acridoid character; caudal tarsi with proximal article comprising nearly half of total tarsal length, its dorsal surface carinatotectate, arolium well developed but narrow, tarsal claws simple, subequal in length.

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[29] From the Mohave Desert, in which the genus occurs, and 'ακρις, *a locust.*

Genotype.—*M. timberlakei* new species.

Mohavacris timberlakei [80] new species Figs. 9-11, 17-18.

Type.—♂; Highway 138, Mohave Desert, California.[81] Elevation, 3600 feet. April 20, 1947. (Edith M. Timberlake.) [Academy of Natural Sciences of Philadelphia, Type no. 5751.]

Size medium; body with compression of proximal portion of abdomen marked, apex of abdomen appreciably clavate and upturned; surface asperities of varying size but with a definite pattern of distribution.

Head with its exposed dorsal length equal to three-fourths the median length of the pronotum, the greatest breadth across eyes equal to 1.25 times the head length, occiput arcuately ascending to interocular space, the latter

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[80] This species is dedicated to Dr. and Mrs. P. H. Timberlake, who collected the unique type. Dr. Timberlake advises me the type was not swept from vegetation, but that Mrs. Timberlake picked up this specimen with her fingers.

[81] Dr. Timberlake has amplified the data on the unique type by advising me (in litt.) that the exact locality at which it was taken "is near the north base of the San Gabriel Mountains in Los Angeles County, but near the San Bernardino line. . . . It is in the Juniper zone. . . . It is a good place for flowers, including a fine scarlet *Penstemon*". Checking the course of Route 138 in the area immediately to the west of the Los Angeles-San Bernardino county line, and against the given elevation, with detailed topographic charts, shows that the point at which the type of *Mohavacris timberlakei* was taken is probably a few miles east of the little settlement of Llano, and near the course of Rock Creek wash.

subequal to the width of one of the eyes as seen from the dorsum; outline of fastigium as seen in profile subsigmoidally declivent cephalad to the interantennal area, as seen from dorsum the fastigium is faintly longer than broad, its disk deeply excavate declivent, and passing without break into the sulcation of the frontal costa, lateral fastigial margins sublamellately elevated, at least interocular space dorsad of eyes they are rectangulately elevated into distinct lobules, thence, as seen from dorsum they diverge caudad over the occiput, becoming less strongly marked near the occipital base but bearing a series of low nodules, which regularly spaced continue ventro-caudad about eyes and upon the genae, cephalad the lateral margins of the fastigium merge with the similarly sublamellate lateral borders of the frontal costa, which from the interantennal area diverge caudad and reach to the cephalic margins of the eyes, median carina of fastigium very low and delicate and indicated only on the caudal half of the fastigial disk and over the occiput; facial line as seen in profile with the interantennal production marked and rectangulate with immediate apex rounded, thence ventrad the face is appreciably retreating; frontal costa with portion dorsad of median ocellus strongly compressed, the lamellate lateral margins there contiguous with the median sulcation evident only as an impressed line, the single carinate ridge representing the frontal costa ventrad of the median ocellus strongly developed, reaching to the thickened ventral border of the face, which is low obtuse-angulate in outline as seen in cephalic aspect, lateral facial carinae pronounced, straight and subparallel; as seen in cephalic aspect the width of the head across the genae is roughly five-sixths that across eyes (as 40 to 46), the genal outline in the same view straight and subparallel; basal outline of the eyes broad ovate, the axis subvertical, the breadth equal to nine-elevenths of the greatest length (i.e. depth), the latter representing about eleven-twelfths of the infra-ocular depth of the genae, the genae ventrad with a short subvertical carina placed between the lateral facial carina and the ventro-caudal genal angle. Antennae with the attenuation of most articles so decided that when viewed in profile the twelfth article, as a representative one, has its greatest depth contained 6.7 times (as 3.5 to 23) in its length; there is also a slight deplanation of the antennae so that the segmental breadth is faintly greater than the depth, but this is not at all pronounced; similarly there is evident on all of the articles a weak external longitudinal carination or ridge, this lacking on internal side and even weakly evident on the enlarged proximal article.

Pronotum appreciably expanding caudad, with its greatest breadth caudad across lateral lobes equal to 1.25 times the median pronotal length, while that across the lobes cephalad is subequal to the length; cephalic and caudal margins of disk transversely truncate except for the median break in the caudal margin where it is involved with the median carina, width of disk between lateral carinae equal cephalad to but faintly more than half of pronotal length (as 22 to 43) and to three-fourths of the same length caudad (as 33 to 43); median carina entire, relatively low in cephalic two-thirds of pronotum except for a carinal node at cephalic sixth, in caudal third elevated into a subcompressed sublamellate rudder-like structure, which in profile is of rounded outline and involves the median section of the caudal margin, which by a V-shaped notch roundly ascends and forms a part of this structure; lateral carinae subparallel on cephalic two-fifths of pronotum, thence to caudal margin concavely divergent, entire and undivided; lateral lobes with median height to lateral carinae of disk equal to slightly more than three-fifths of the overall lobal length (as 26 to 41), cephalic and caudal margins vertical, subparallel and subrect, ventral margin very faintly sigmoid, ventral angles subrectangular, each very narrowly rounded, surface of lateral lobes with a short vertical impression in the usual position of a transverse sulcus; surface of all of the pronotum and of the cephalic and caudal, but not the ventro-lateral, margins with numerous asperities, some much higher, larger and more distinctly contrasted in color than the others, all arranged in a largely balanced pattern, one arcuate series crossing the disk slightly caudad of the middle, lateral lobes at one-fourth of their height from the cingulate ventral margin with a subparallel longitudinal low cicatrose ridge extending across the whole lobar surface. Mesonotum but narrowly exposed, metanotum more broadly so, each with median and lateral carinae and marginal and surface nodosities as on pronotum, caudal margin of each subtruncate with a shallow median angulate emargination.

Meso-metasterna with lateral borders thickened in places but hardly cingulate, greatest breadth across cephalic portion of metasternum, this nearly equal to five-sixths the median length of the meso-metasterna, cephalad of this point the lateral margins are obliquely and nearly straight convergent for a distance, then are broadly arcuate across the cephalic extremity, from the broadest point caudad the lateral margins are much more decidedly arcuate convergent to a relatively narrow median caudal section, where the margin is shallowly concave; mesosternal lobes roughly subquadrate with their caudal margins slightly oblique-truncate, interspace between mesosternal lobes transverse, equal to 1.5 times the breadth of one of the lobes, metasternal foveolae with their axial length transverse, their outline elongate trigonal, their apices laterad, their bases separated by the narrow median septum and both over-arched cephalad by a rim-like gable of the metasternum, which shows no division into lobes but bears a shallow median impressed sulcus for a short distance cephalad of the foveolae.

Abdomen with the median carina strongly marked caudad to the ultimate tergite, lateral carinae much more weakly indicated to the same point, surface nodosities numerous, but less marked and less elevated distad than on the more proximal tergites; ultimate tergite developed ventro-laterad of the cercal bases into deep vertical lobes, the distal margin of which, as seen in profile, is broadly truncate and rounding dorsad into the broad subcercal marginal section, which is concave; supra-anal plate with its greatest breadth (between cercal bases) subequal to its median length, trigonally converging lateral margins shallowly concave, apex rather narrowly rounded, surface of plate with a median transverse shelf-like division, which laterad is formed by oblique distad converging low lamellations, these joined mesad by a transversely truncate much lower surface structure, medio-longitudinal area of proximal half of surface with a very shallow impression, this narrowing distad; cerci slightly surpassing the apex of the supra-anal plate, as seen in profile virtually straight, seen from dorsum with distal third lightly incurved, apices narrowly rounded; subgenital plate with its distal margin little surpassing the cercal apices in caudal extent, as seen from dorsum its rather narrow distal margin is subtruncate with limiting lateral nodes, which when viewed in caudal aspect are seen to be the dorsal extremities of the paired lateral sections of the subgenital plate, in caudal aspect this distal margin is obtuse-angulate emarginate, lateral sections of the subgenital plate subvertical relatively narrow structures, subacute dorsad, and as seen in caudal aspect both of them are moderately but rather sharply constricted briefly ventrad of the disto-dorsal margin, the caudal margins of the two lateral sections as viewed in caudal aspect thus forming together an hourglass shaped figure, median portion of the subgenital plate with the median vertical ridge forming a fin-like structure the outline of which, as seen in profile, is arcuate, its elevation progressively lower ventrad, proximo-ventral margin of the subgenital plate approximately transverse truncate;[82] ultimate sternite relatively broad, deep and entire.

Cephalic femora with their length equal to 1.75 times that of pronotum (as 43 to 76), their greatest depth proximad of the genicular lobes hardly more than one-seventh of their depth, very slightly arcuate as seen in profile, dorsal surface with a pair of longitudinal carinae of which the cephalic is the more prominent and more regular, a ventral pair of carinae well marked, cephalic (internal) face with a weak medio-longitudinal carinula; cephalic tibiae slightly longer than the femora (as 85 to 76), not carinate dorsad; median femora slightly shorter than cephalic pair (as 69 to 76), faintly stouter, slightly expanding in depth distad, virtually straight, carination as on cephalic femora. Caudal femora when extended caudad surpassing the apex of the abdomen by a distance but slightly less than the body length, very slender, greatest depth, which is at proximal fifth, equal to less than one-sixth of their length (as 31 to 207), medio-dorsal carina sublamellately elevated, ventro-external carina more strongly developed than dorso-external one, pattern of the external pagina with the greater part of its surface bearing an oblique series of seven marked subparallel cariniform rugae, all femoral carinae except paginal ones with a greater or lesser development of spaced nodosities, plus on the dorsal and ventro-external surfaces of a denser pattern of similar sculpture of a minor category, extremity of medio-dorsal carina spinose, genicular lobes and genicular angles unspined; caudal tibiae very slightly longer than the femora, external and internal margins each with 14 spines, external spurs of subequal length, internal pair with the extensor one about 1.5 times as long as the flexor; caudal tarsi equal to slightly more than one-third the tibial length (as 62 to 211), second article equal to one-third the length of proximal one.

Coloration.—Pale base color cinnamon-buff, this very largely and variably overlaid with washes, cloudings and innumerable stipplings which range from mummy brown to fuscous-black. The more evident features of the pale pattern are: the lining of the lateral carinae from the postocular region virtually to the abdominal apex; a similar but less solidly cut pale lining on each side reaching from the lateral facial carinae across the genae, following both the cicatricose ridge on and the ventral margin of the pronotal lateral lobes, and evident again on the sides of the abdomen near the apex; and a proximo-dorsal and several external paginal areas on the caudal femora. The most conspicuous darker elements are paired relatively broad solid areas ventrad of the pale lateral carinae on the head and pronotum, also evident again on the side of the abdomen distad; the pin-point infuscation of most of the larger, and many of the smaller, nodose surface points, these with fuscous-black, thus producing a pronounced " pepper and salt " effect. The antennae are obscurely annulate light and dark, but this is not clearly evident and is not made up by individual articles being contrastingly colored as in *Tanaocerus*. The eyes are buckthorn brown, clouded in ventral half with mummy brown stipplings. The blotching of the cephalic and median limbs is strongly contrasted, and all the tarsi are biannulate with fuscous on a paler ground. The sternum and ventral surface of much of the abdomen is ochraceous-tawny with darker over-stipplings. The spines of the caudal tibiae are each pale in the middle and fuscous-black at base and apex.

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[82] There is some infolding of integument in this area in the unique type, and it is possible the exact position of certain of the elements of the subgenital plate may be somewhat different in fresh material.

Measurements.—Length of body, 10. mm.; length of head, 1.5; length of antenna, 21.7; length of pronotum, 2.1; length of caudal femur, 10.3; length of caudal tibia, 10.5.

The type of this remarkable genus and species is unique, and the discovery of the female sex and the acquisition of more information as to its distribution and habits are awaited with great interest.

EXPLANATION OF PLATE

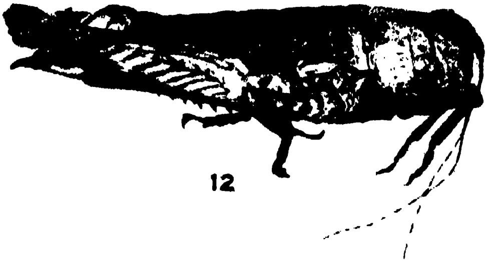
PLATE 1

Figs. 12-13.—*Tanaocerus koebelei koebelei* Bruner. Female. Amargosa Desert, twenty-five miles south of Beatty, Nye County, Nevada. 12.—Lateral view (× 4). 13.—Dorsal view (× 4).

Figs. 14-15.—*Tanaocerus koebelei koebelei* Bruner. Male (allotype). Four miles north of Wild Rose, Panamint Mountains, Inyo County, California. 14.—Lateral view (× 4). 15.—Dorsal view (× 4).

Fig. 16.—*Tanaocerus koebelei albatus* new subspecies. Female (type). Palm Springs, Riverside County, California. Lateral view (× 4).

Figs. 17-18.—*Mohavacris timberlakei* new genus and species. Male (type). Mohave Desert, San Bernardino County, California. 17.—Lateral view (× 4). 18.—Dorsal view (× 4).



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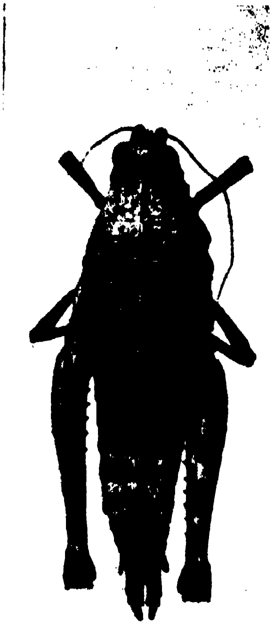

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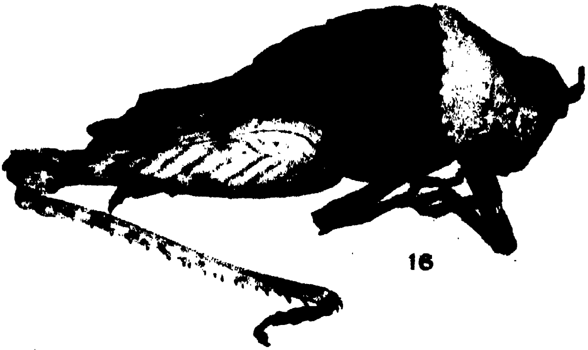

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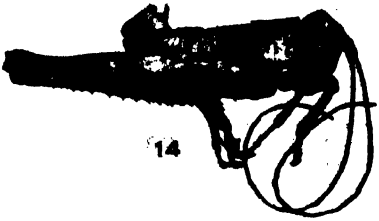

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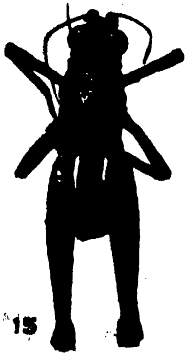

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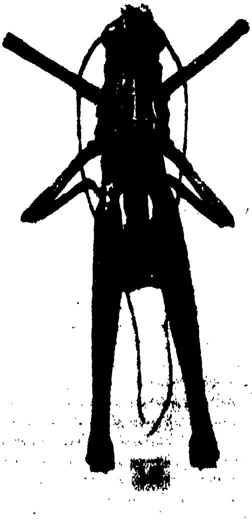

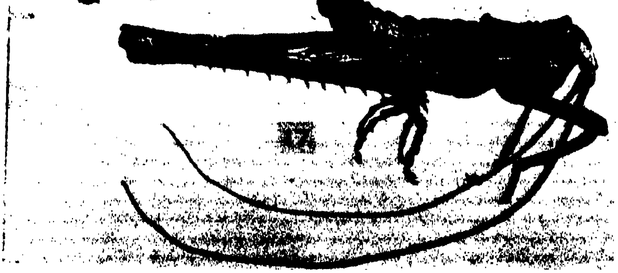

17

REHN: GENUS TANAOCERUS

A HADROSAURIAN DINOSAUR FROM NEW JERSEY

BY EDWIN H. COLBERT[1]

Introduction

Hadrosaurs, or duck-billed dinosaurs, have been known from the Upper Cretaceous of New Jersey for almost one hundred years. It was in the year 1858 that the partial skeleton of a hadrosaur was discovered on the farm of Mr. W. Parker Foulke, near Haddonfield, New Jersey. This specimen, incidentally the first dinosaur skeleton of some completeness to be discovered in North America, was placed in the collections of the Academy of Natural Sciences, where for many years it was on exhibition. It was described by Joseph Leidy as the type of *Hadrosaurus foulkii,* the species being in turn the type species for the genus.

Subsequently various hadrosaurian bones were discovered in New Jersey, and some of these became the subjects of short notices by a number of authors. But all of these later finds were of fragmentary or very incomplete materials—portions of leg bones or a few vertebrae—so that none of them offered very satisfactory supplementary evidence, beyond that already obtained from the type of *Hadrosaurus foulkii,* concerning hadrosaurs in the Cretaceous sediments of New Jersey.

During the fall of 1947 a new hadrosaurian discovery was made in New Jersey, and it constitutes the best materials recovered from this region since the original find of 90 years ago. Although this new hadrosaur is far from being a complete skeleton it does compare favorably with the type of *Hadrosaurus foulkii* (itself far from complete), and because of the amount of bone recovered, and in addition because of the stratigraphic position in which it was found, it offers some new and useful evidence regarding the presence of these dinosaurs in the Cretaceous of eastern North America. This newly discovered hadrosaur forms the subject of the present paper.

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[1] Curator, The American Museum of Natural History, New York. Associate Curator, Academy of Natural Sciences of Philadelphia.

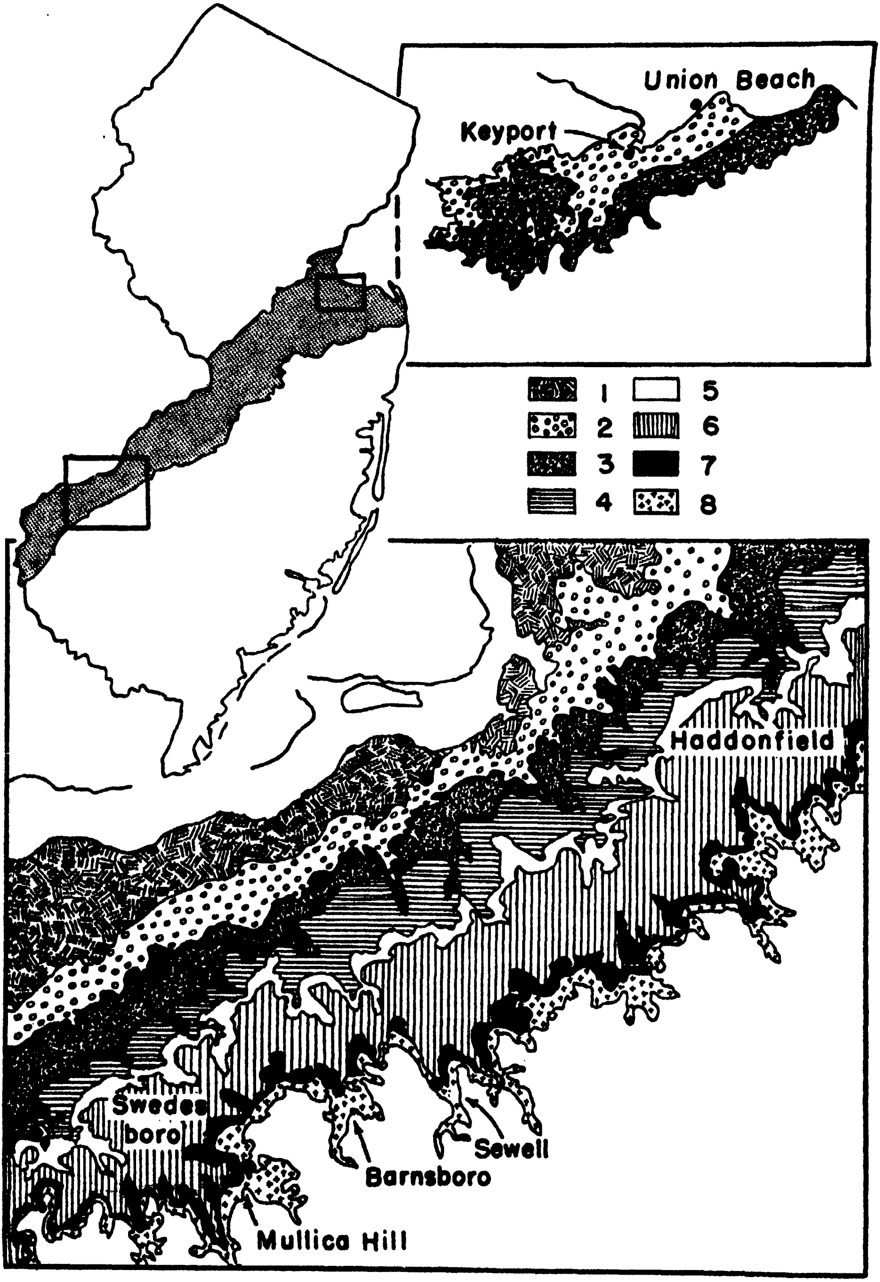

Fig. 1. See bottom of page 25 for legend.

Discovery

The specimen was discovered in a pit of the Hungerford and Terry Corporation, near Sewell, New Jersey, where glauconitic sands forming the Navesink formation are being mined for the manufacture of water-treating compounds. The first bones were noticed by some of the employees of the company, who immediately informed Dr. Horace G. Richards of the Academy staff. Dr. Richards made a preliminary investigation of the discovery and the site, and as soon as it became apparent that this was more than the chance occurrence of a few scraps of bone he wrote to me about the find.

I then went to the site, accompanied by Mr. Joseph Tassoni, a graduate student in Zoology at Columbia University, and in company with Dr. Richards and Mr. John Parker of the Academy staff we prospected the pit further. The result was that we found additional bones, and it became apparent that some careful work would have to be done in this locality.

Arrangements accordingly were made for Mr. Carl Sorensen of the Paleontological Laboratory of The American Museum of Natural History, New York, to spend as much time as necessary in excavating the fossil. This, Mr. Sorensen did, with the assistance of Mr. Parker. The bone level was followed into the face of the workings until it became apparent that further digging would yield nothing of value. Unfortunately no skull was found, as had been hoped for, but various skeletal elements were excavated, all apparently from a single individual. Fortunately the officers and employees of the Hungerford and Terry Corporation are very much interested in the fossils discovered in their pits, and they will be on the alert in the future for additional materials that may show up in the course of their operations. Therefore, it is still possible that more bones of this dinosaur or of other dinosaurs may be brought to light at some time in the future.

Various people have aided in the recovery and preparation of the material to be described in this paper, and to them I wish to offer grateful appreciation for their interest and aid. To Mr. Churchill Hungerford, Jr., president of Hungerford and Terry, owners of the pit, to Mr. Stephen Straga, foreman, and to Messrs. Raymond Ferarra and Charles Miranda, who were working in the pit at the time of the discovery, we owe an especial vote of thanks, not only for finding the first bones of this specimen, but also for

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Fig. 1.—Geologic maps of the areas in which hadrosaurs have been discovered in New Jersey. The inset map of New Jersey shows the belt of Cretaceous strata running across the state. The outlined squares show the locations of the two detailed maps.

Data for detailed maps taken from the Geologic Map of New Jersey, Department of Conservation and Development, Atlas sheet number 40. Revised Edition, 1931. Scale: 1:250,000.

Key to symbols.—1.—Magothy—Raritan formations. 2.—Merchantville clay. 3.—Woodbury clay. 4.—Englishtown sand. 5.—Marshalltown formation. 6.—Mount Laurel—Wenonah sands. 7.—Navesink marl. 8.—Hornerstown marl.

their interest and their efforts to facilitate in every way possible our work at the pit. It was through the cooperation of these gentlemen that this dinosaur was preserved for study and made available for the collections of the Academy of Natural Sciences of Philadelphia. To Dr. Horace G. Richards of the Academy much credit is due for vigorously prosecuting the excavation of the fossil. To Mr. Carl Sorensen of The American Museum of Natural History goes the credit for completing the excavation and for preparing some of the more difficult material. Dr. Richards and Dr. Jack Graham of the United States Geological Survey donated some of their time to the preparation of the specimen.

The photographs of fossils illustrating this paper were made by Mr. A. Delwin Warden of the Academy staff. The drawings were made by Miss Shirley Lapp.

Geological Relationships

The hadrosaurian remains with which this paper is concerned come from the Navesink formation in the vicinity of Sewell, New Jersey. As mentioned above, the bones were found in green glauconitic sands, which in this area form a bed of considerable thickness. These sands have been mined for many years, and it is an interesting fact that in past years other fragments of hadrosaurian dinosaurs have been found not far distant from the site of the present discovery. These earlier finds are recorded as coming from Barnsboro, Swedesboro and Mullica Hill, all within ten miles of Sewell.

The Navesink greensands at this locality are very soft and loose, and are worked at the present time by hydraulic methods. It is inevitable that the fossil bones occurring within these sands should be soft and fragile, and their excavation must be carried forward with the greatest of care.

The pits in which the Navesink glauconite is exposed in this area do not extend to the base of the formation. Subsequent to deposition of the greensands there was erosion in this region so that the Redbank formation, commonly found above the Navesink, is here missing. Consequently the Eocene Hornerstown marl immediately overlies the Navesink here, and since in its basal phases the Hornerstown is at this place made up to a large degree of reworked greensands, it is exceedingly difficult to distinguish the line of demarcation between the Cretaceous and the Eocene. The dinosaur bones were excavated at a level not more than five or six feet below the Cretaceous-Eocene line. A few feet above this line there were found rather numerous bones of turtles and crocodilians of Hornerstown age.

It should be said here that associated with the hadrosaur bones in the Navesink greensands were shells of the mollusc, *Cucullaea*. It is known that glauconite is a mineral of marine origin, being formed in part by the decay of Foraminifera. This fact, together with the presence of the mollusc shells, indicates that the hadrosaurian bones were deposited in an off-shore facies, which is not surprising since the hadrosaurians were all aquatic dinosaurs, capable of swimming away from the shore to considerable distances. They commonly lived along beaches, and river and lake margins, so that their remains frequently are found in deposits of marine or lacustrine origin.

The site of the discovery at Sewell and the relationships of the Navesink and Hornerstown formations are shown in text figures 1 and 2 and plate 2a.

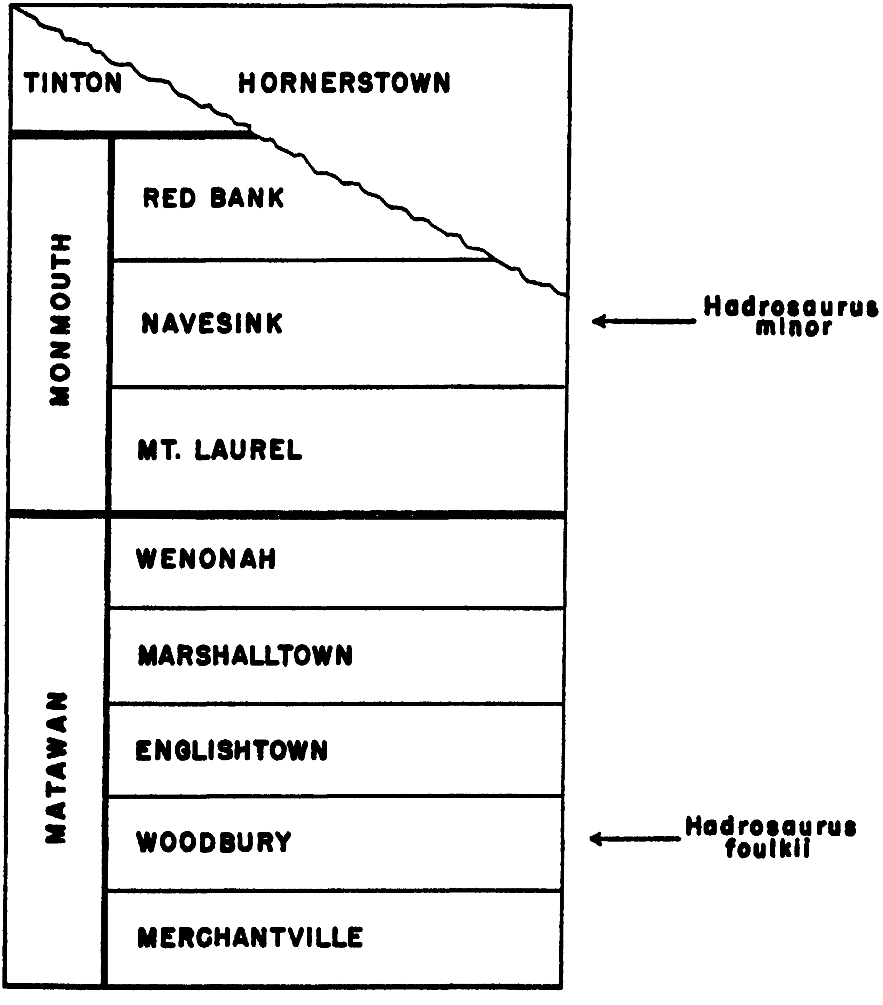

Fig. 2.—Diagram showing the relationships of upper Cretaceous (Merchantville—Tinton) and Lower Eocene (Hornerstown) sediments in New Jersey.

Materials

The fossils recovered from the marl pit at Sewell are, as mentioned above, pretty definitely all from a single individual. The bones have been identified as follows:

Acad. Nat. Sci. Phila., No. 15202.
Right pubis, almost complete.
Portion of right ischium.
Right femur, almost complete.
Left femur.
Portion of left fibula.
Five anterior dorsal vertebrae.
Six anterior caudal vertebrae, five of these probably in series.
Two posterior caudal vertebrae.
Neural spine, possibly from a cervical vertebra.
Three neural spines, from dorsal vertebrae.
Four transverse processes.
Thirteen ribs, in various stages of preservation.
A complete chevron.
Three fragmentary chevrons.
Numerous bone fragments, too poorly preserved for identification.

Description

Hadrosaurus minor Marsh Text-figs. 3 and 4; plates 3-7.

Hadrosaurus minor Marsh, 1870. Proc. Acad. Nat. Sci. Philadelphia, vol. 22, p. 2.

Type.—Yale Peabody Museum, No. 1600, several presacral vertebrae.

Horizon.—Navesink formation, Cretaceous.

Locality.—Near Barnsboro, New Jersey.

Diagnosis.—A small species of hadrosaur, about one fourth smaller in linear measurements than *Hadrosaurus foulkii.* Prepubic portion of pubis elongated—very similar in shape to the same element in *Anatosaurus.* Ischium attenuate, pointed at distal end.

The new materials discovered from Sewell, which form the basis of this contribution, are here referred to the species *Hadrosaurus minor* Marsh. The reasons for this assignment are given on subsequent pages of this paper.

Pubis.—It is fortunate that among the materials found at Sewell, an almost complete right pubis was recovered. Except for the posterior tip of the pubis and a small portion of the anterior border of the prepubis this element is complete, thereby affording some of the most useful and diagnostic information on this newly discoverd hadrosaurian. The bone is rather small, considerably smaller than the same bone in a characteristic *Trachodon* or *Corythosaurus,* larger than the pubis in the genus *Procheneosaurus.*

The pubis in the original *Hadrosaurus* from Haddonfield is unknown, so a direct comparison is impossible.

Of particular importance is the shape of this bone; it is elongated and slender, especially in its prepubic portion. In front of the acetabular border the bone narrows into a long " neck ", and then anteriorly it flares into a flattened blade. The shape very closely resembles that of the same bone in *Trachodon* (or *Anatosaurus*, as it recently has been designated by Lull and Wright). A careful comparison has been made between this new pubis and the pubic bone in all of the other hadrosaurian genera from North America, and it is quite evident from this comparison that the greatest similarity is to be found with *Trachodon.* In no other genus does the prepubis have the elongated form that is to be seen in *Trachodon,* and in this specimen from Sewell.

The resemblance is evident from the comparative outlines shown in text figure 3.

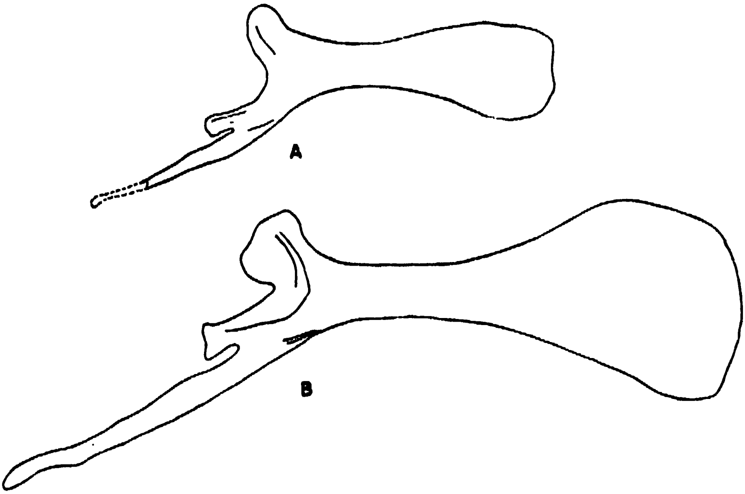

Fig. 3.—Outline drawing showing the pubis in (A) *Hadrosaurus minor,* A.N.S.P. No. 15202, and in (B) *Anatosaurus copei,* A.M.N.H. No. 5730. One-tenth natural size.

Ischium.—A fragment of an ischium was discovered in the Sewell pit. Unfortunately this fragment is small, but it is nevertheless large enough and characteristic enough to make its identification fairly certain. It is a part of the " blade " of the ischium, rather slender and definitely tapering from one end to the other. This would indicate that the bone terminated posteriorly in a point, rather than in an expanded " foot ". Here again we see a resemblance to *Trachodon.* Moreover, the resemblance here is with the original *Hadrosaurus* as well, of which the ischium is rather well preserved.

Femur.—The femora are well preserved in the Sewell hadrosaur—perhaps because these are large, solid bones, well able to withstand the vicissitudes of sedimentary processes. These are typical hadrosaurian femora, heavy and strong and each is very straight, especially as viewed from in front. These femora are much smaller than the same bones in the type of *Hadrosaurus foulkii,* being only about three fourths as great in linear dimensions. Accordingly the disparity between the bones being compared is even greater as regards their volume and mass.

The head is prominent, and offset toward the inner aspect of the femur, as is usual in the hadrosaurians. External to the head is the well-developed great trochanter, while midway down the shaft of the femur is the fourth trochanter, a very prominent process. In this Sewell individual the fourth trochanter is proportionately very large. Distally there is a well-developed groove on the anterior surface of the bone, between the two distal condyles. In many hadrosaurs this groove or cleft is closed over by contact of the condyles, thus forming a channel for the tendons of the extensor muscles passing to the lower leg. Such a condition is seen in the Haddonfield specimen. But in the Sewell specimen, perhaps because of its much smaller size, there is no such close approximation of the condyles, with the consequent overgrowth of the bone, and the groove on the front of the femur is open.

Fibula.—A section of a fibula is present among the bones recovered from the Sewell pit. This is an elongated, slender bone, rather flattened, and it shows a distinctive tapering from one end to the other in that portion present. Quite obviously the smaller end of the bone fragment is the more proximal portion of the fibula, while the broader end is its more distal portion.

Vertebrae.—The dorsal vertebrae preserved in the Sewell material are obviously from the anterior part of the column, and such being the case they are strongly opisthocoelous. The anterior articular surface of the centrum is very strongly rounded, in which respect the resemblance is with other known hadrosaurians. The vertebral centra are rather long in comparison with their diameters, an indication of the forward position of these vertebrae in the dorsal series. The prezygapophyses, so far as they are preserved, are fairly flat, with their surfaces directed dorsally. In one vertebra a part of the spine is present.

The best of the vertebrae are those from the anterior portion of the caudal region. Several of these vertebrae are rather well preserved. The centra of these vertebrae are platycoelous, large in diameter, and constricted anteroposteriorly. Thus the centra form enlarged, closely appressed articulating units, necessary for a large tetrapod with a strong, heavy tail. The zygapophyses are well developed; the anterior ones are directed up and medially, the posterior ones down and laterally. There are elongated transverse

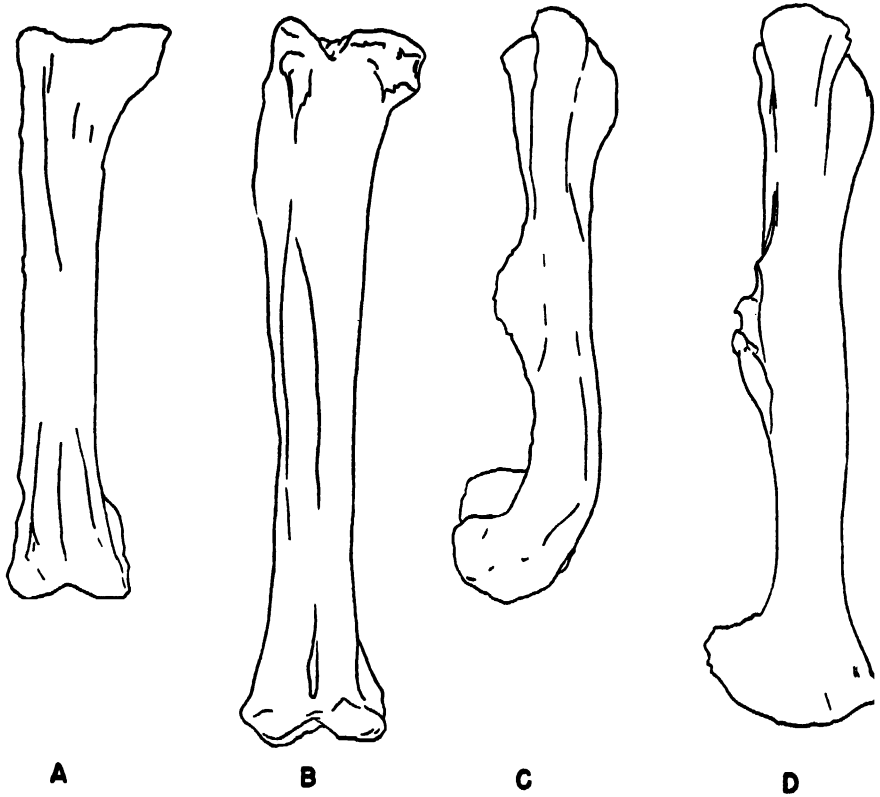

Fig. 4.—Outline drawings showing the femur in (A, C) *Hadrosaurus minor,* A.N.S.P. No. 15202, and in (B, D) *Hadrosaurus foulkii,* A.N.S.P. No. 10005. Anterior and medial views, one-tenth natural size.

processes. The strong vertebral spines are directed posteriorly, to angles of about 45 degrees.

The few posterior caudals preserved show that these vertebrae were rather elongated and platycoelous. Only the centra are present, but there is every reason to think that in all respects these vertebrae were similar to the same elements in other hadrosaurians.

So far our comparisons have been with hadrosaurians in general, and more specifically with *Hadrosaurus foulkii.* It was mentioned above, in the description of the femora, that these bones indicated the Sewell hadrosaur to be considerably smaller than the animal described so many years ago from Haddonfield. It was pointed out that linearly the difference is on the order of 25 percent, which makes the difference in mass very considerable indeed. The same comparison is possible with the anterior caudal vertebrae. Comparing certain vertebrae from the Sewell specimen with what seem to be vertebrae from about the same region of the body in *H. foulkii*, a size difference similar to that seen for the femora is apparent. In other words, the vertebrae of the Sewell specimen show linear measurements about 25 percent smaller than those of *Hadrosaurus foulkii*.

With regard to these vertebrae another comparison is possible. In 1870 Marsh described a hadrosaur from near Barnsboro, New Jersey, which he called *Hadrosaurus minor*. This species was founded upon several vertebrae from the back region. It is an interesting fact that the vertebrae described by Marsh are closely comparable in dimensions with the vertebrae from the Sewell specimen. This is particularly significant when one considers that the type of *Hadrosaurus minor* was found within a few miles of the specimen now under consideration and that in all probability *H. minor*, like the hadrosaur from Sewell, came from the Navesink formation. Thus there is reason to believe that the hadrosaurian material from the Navesink formation represents a distinct species, smaller and later in geologic age than *Hadrosaurus foulkii* from the Woodbury formation near Haddonfield.

The size comparisons outlined above are illustrated by the accompanying diagrams, text figure 5.

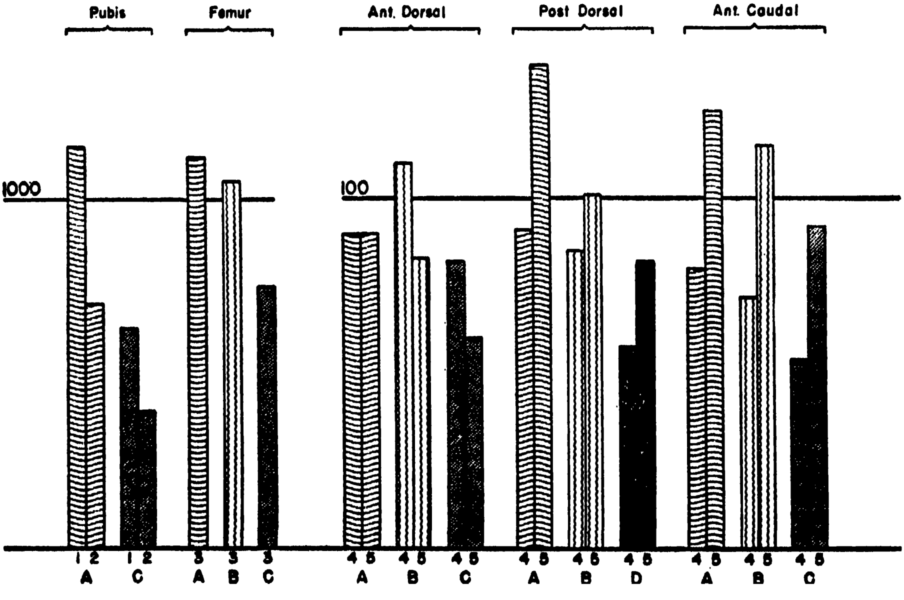

Fig. 5.—A comparison of certain measurements in various hadrosaurs. A.—*Anatosaurus copei* (type), A.M.N.H. No. 5730. B.—*Hadrosaurus foulkii* (type), A.N.S.P. Nos. 9201, 9203, 10005. C.—*Hadrosaurus minor*, A.N.S.P. No. 15202. D.—*Hadrosaurus minor* (type). Y.P.M. No. 1600. 1.—Pubis, length. 2.—Prepubis, length. 3.—Femur, length. 4.—Centrum of vertebra, length. 5.—Centrum of vertebra, height.

Chevrons.—A number of chevrons were discovered in the Sewell pit. One of these, a large element evidently from the anterior or middle portion of the tail, is virtually complete. It is shown in plate 7.

Ribs.—Quite a number of broken ribs were found. These warrant no particular discussion.

Comparative Measurements (in millimeters)

	H. minor A.N.S.P. 15202 Sewell	*H. minor* type Y.P.M. 1600 1593, 1587 Barnsboro, Mullica Hill Swedesboro	*H. cavatus* type A.M.N.H. 1390 Swedesboro	*H. foulkii* type A.N.S.P. 9201, 9203, 10005 Haddonfield	*Anatosaurus copei* type A.M.N.H. 5730 S. Dakota
Pubis					
Total length	540 + (624 est.)				1150
Length of prepubis	390				700
Anterior vertical diameter of prepubis	148				246
Femur					
Total length	746			1055	1120
Proximal breadth	200			240	300
Distal breadth	160			200	245
Breadth/mid-shaft	99			140	180
Anterior dorsal					
Centrum length	82			110	90 [2]
Centrum height	60			83	90
Centrum transverse	60			78	80
Posterior dorsal					
Centrum length		58		85	91 [3]
Centrum height		82		101	138
Centrum transverse		76		101	158
Anterior caudal					
Centrum length	54			72	80 [4]
Centrum height	92			115	125
Centrum transverse	115			120	130
Median caudal					
Centrum length			72		77 [5]
Centrum height			71		80
Centrum transverse			82		98

[2] 18th presacral.

[3] 32nd presacral

[4] 6th caudal.

[5] 25th caudal.

Fragments.—Many fragments of bone were excavated from the Sewell pit. Although impressive as to number, these bones are of little if any use in the present study, since they are too fragmentary for certain identification. They do indicate, however, that a fairly complete hadrosaur skeleton may have been originally deposited at the Sewell locality, only to be broken and disintegrated by subsequent sedimentary processes.

The Hadrosaurs of New Jersey

Prior to the discovery of hadrosaurian bones at Sewell, New Jersey, remains of these dinosaurs had been found at a number of New Jersey localities, as follows:

Haddonfield
  Woodbury formation
    Partial skeleton (mandibular teeth, 28 vertebrae, humerus, radius, ulna, ilium, ischium, femur, tibia, fibula, 2 metatarsals, phalanx).
  Hadrosaurus foulkii Leidy, 1858. Type of genus.
Union, shore of Raritan Bay
  Horizon not definitely known (Woodbury?)
    Distal portion of left tibia and fibula, with coossified astragalus and calcaneum.
  Ornithotarsus immanis Cope, 1869. Type of genus.
Barnsboro (also Mullica Hill and Swedesboro)
  Navesink formation
    Several dorsal and lumbar vertebrae.
  Hadrosaurus minor Marsh, 1870.
Swedesboro
  Probably Navesink formation
    Four caudal vertebrae.
  Hadrosaurus cavatus Cope, 1871.

In addition to the discoveries listed above, there are miscellaneous hadrosaurian bones from New Jersey in the Cope Collection at the American Museum of Natural History, for which there are no locality records.

Of the hadrosaurs from New Jersey as recorded in the literature, the type specimen of *Hadrosaurus foulkii* can be considered as adequate. Indeed, this is the original hadrosaurian dinosaur, and as such it forms the base from which stems all of our present-day knowledge of the duck-billed dinosaurs. The other discoveries in New Jersey, with the exception of the material recently found at Sewell, must be considered as very inadequate, particularly for taxonomic purposes.

The status of *Ornithotarsus immanis* is at best very weak. This seemingly represents a very large hadrosaurian, larger than any others known from the eastern Cretaceous, but until additional material is forthcoming nothing definite can be said concerning this supposed species. Unfortunately our information as to the stratigraphic level of this discovery is not clear.

There remain to be considered the hadrosaurs discovered at Barnsboro, Swedesboro and Mullica Hill. It is an interesting fact that all of these localities are close to Sewell. Moreover, it seems very probable that all of these discoveries, like the recent find at Sewell, were made in the Navesink formation, although it is possible that the materials found near Swedesboro may come from one of the lower horizons in this region. They were made during the working of the greensands in this part of New Jersey, and the Cretaceous greensands here are contained within the Navesink.

Marsh described *Hadrosaurus minor* upon the basis of a few vertebrae. Subsequently Cope described *Hadrosaurus cavatus* upon the basis of four caudal vertebrae. As has been shown above, there is a close correspondence in size between the type of *Hadrosaurus minor* and comparable vertebrae found in the Sewell pit. Unfortunately the vertebrae constituting the type of *Hadrosaurus cavatus* cannot be compared directly with either the *Hadrosaurus minor* vertebrae or the vertebrae from the Sewell pit, since they come from a part of the vertebral column not represented in these latter two discoveries. It must be admitted, however, that the vertebrae of *Hadrosaurus cavatus* appear to represent an individual somewhat larger than the type of *Hadrosaurus minor* or the hadrosaur from Sewell.

From the evidence of the type material of *Hadrosaurus minor* and the material from Sewell it would seem likely that there was a comparatively small species of *Hadrosaur* living in eastern North America during the deposition of the Navesink sediments. This species, according to the laws of priority, is *Hadrosaurus minor* Marsh, and it is to this species that the new material from Sewell is referred.

Of course it might be argued that the smaller *Hadrosaurus* indicated by these materials represents a size variation of *Hadrosaurus foulkii.* Naturally this is quite possible. But in view of the stratigraphic separation of the Woodbury and Navesink formations, it seems logical to assume that the hadrosaurians contained within them may very well be specifically different. The evidence afforded by *Hadrosaurus cavatus,* inadequate though it may be, does tend to complicate this picture. Here, it would seem, is a relatively large hadrosaur, probably from the Navesink. Does this represent a third species, or does it represent the persistence of *Hadrosaurus foulkii* from Matawan into Monmouth times? Or, as another possibility, was the type of *Hadrosaurus cavatus* actually found in a lower horizon—perhaps the Woodbury? No definite answers can be given to these questions until more material is available.

It was pointed out above that the original type material of *Hadrosaurus minor* is inadequate. However, if we now consider the new materials from Sewell as of this species, then we may assume that the species rests upon a much firmer foundation than it formerly did. It can be considered as a species of which we have a certain amount of definite and diagnostic information. And this information covers not only such quantitative characters as those of size and proportions, but also qualitative characters with regard to the form of the bones. Some of these latter, especially the shape of the pubis can be considered as diagnostic.

With these considerations in mind, certain conclusions can be made with regard to the hadrosaurs of the New Jersey area. During Matawan times there was a large hadrosaur, *Hadrosaurus foulkii*, now known from the Woodbury formation. During Monmouth times there was a relatively small hadrosaur, *Hadrosaurus minor*, now known from the Navesink formation. Both of these species seemingly were closely related to the western form commonly known as *Trachodon*, recently designated by Lull as *Anatosaurus*. This is shown especially by the development of the pelvic elements. Also in the upper Cretaceous of New Jersey there was a large hadrosaurian probably of Navesink age that may represent either the persistence of *Hadrosaurus foulkii* over a considerable lapse of geologic time or the development of a large species separate from *Hadrosaurus foulkii*. This form, at present known from inadequate material, was described by Cope as *Hadrosaurus cavatus*. Finally, there was in the upper Cretaceous of New Jersey a very large hadrosaurian, now known upon the basis of very inadequate material as *Ornithotarsus immanis*. The status of this enigmatic form must await future discoveries for clarification.

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EXPLANATION OF FIGURES

PLATE 2

A.—The pit at Sewell, New Jersey. Hungerford and Terry Corporation. The bone level is at about the shoulder height of the lower figure. The dark material in the lower half of the photograph is Navesink (Cretaceous); the slightly lighter material in the upper part of the picture is Hornerstown (Eocene).

B.—The pit at Sewell, New Jersey. Hungerford and Terry Corporation. The contact between the Navesink below and the Hornerstown above is approximately at the level of the lowest pipes. The two lower figures are standing at the Bone Level.

C.—Distal end of *Hadrosaurus* femur in place. Hungerford and Terry corporation pit, Sewell, New Jersey.

PLATE 3

A.—*Hadrosaurus minor* Marsh. A.N.S.P. No. 15202, right pubis. External lateral view, one-fourth natural size.

B.—*Hadrosaurus minor* Marsh. A.N.S.P. No. 15202. A. Left, portion of right ischium. B. Right, portion of left fibula. Lateral views, one-fourth natural size.

PLATE 4

Hadrosaurus minor Marsh. A.N.S.P. No. 15202. Right femur, anterior view; left femur, medial view. One-fifth natural size.

PLATE 5

Hadrosaurus minor Marsh. A.N.S.P. No. 15202, anterior dorsal vertebrae. Anterior and lateral views, one-fourth natural size.

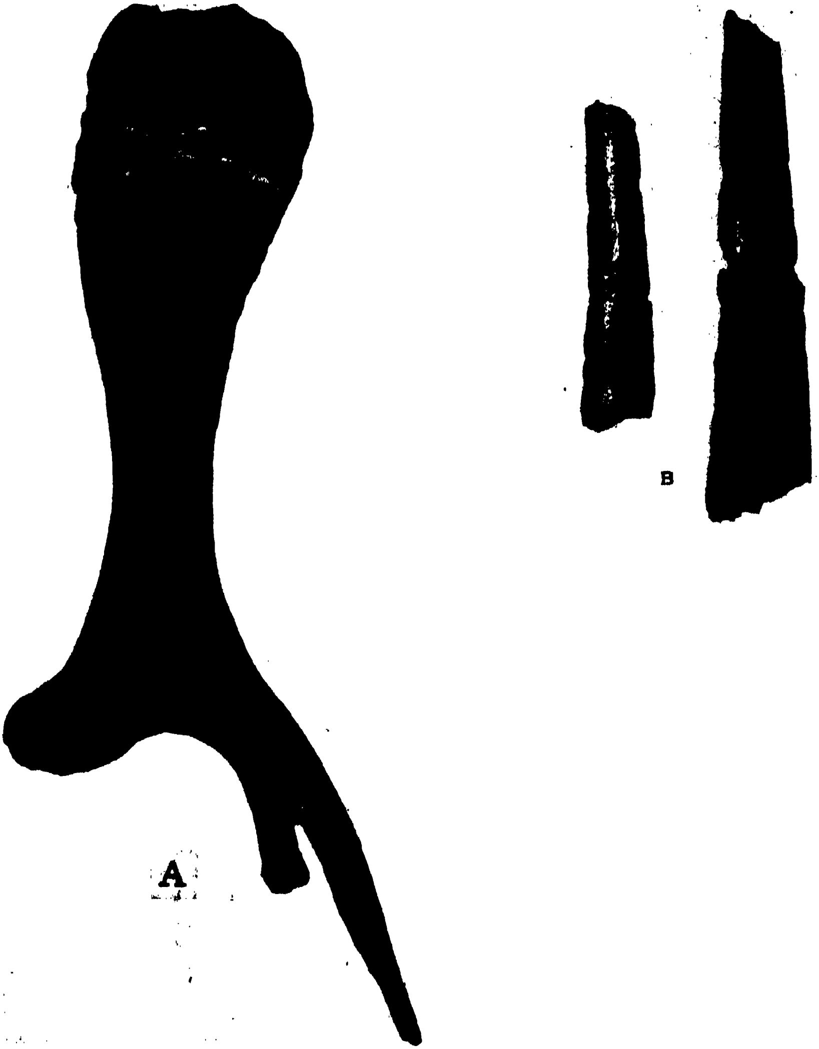
PLATE 6

Hadrosaurus minor Marsh. A.N.S.P. No. 15202, anterior caudal vertebrae. Above, anterior views. Below, posterior views. One-fourth natural size.

PLATE 7

Hadrosaurus minor Marsh. A.N.S.P. No. 15202, anterior and posterior caudal vertebrae and chevron. Above, anterior caudals, lateral view. Middle, posterior caudals, lateral view. Below, chevron, posterior view. Vertebrae approximately one-fourth natural size; chevron approximately two-thirds natural size.

COLBERT: HADROSAURIAN DINOSAUR



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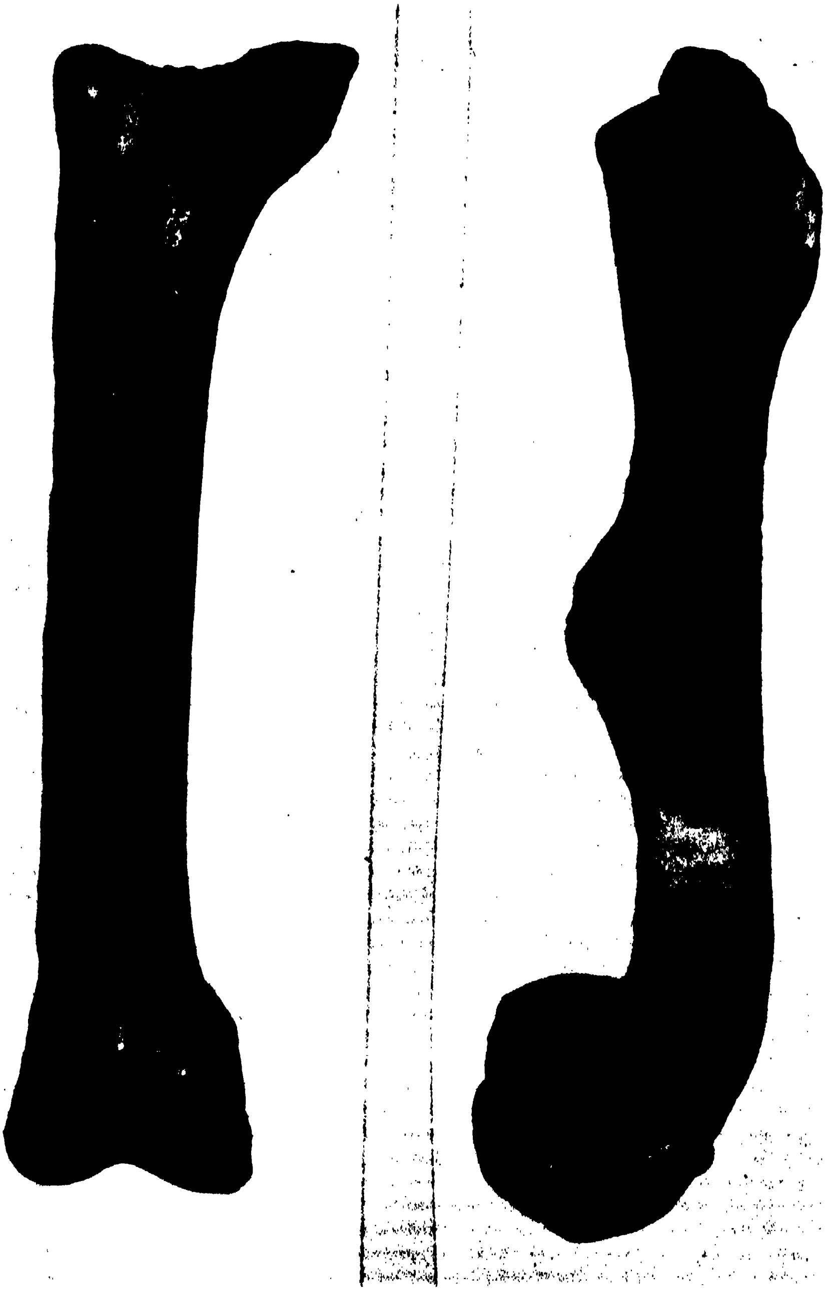

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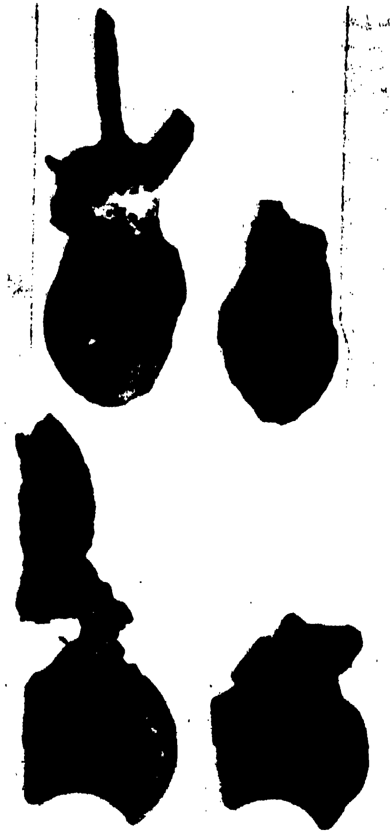

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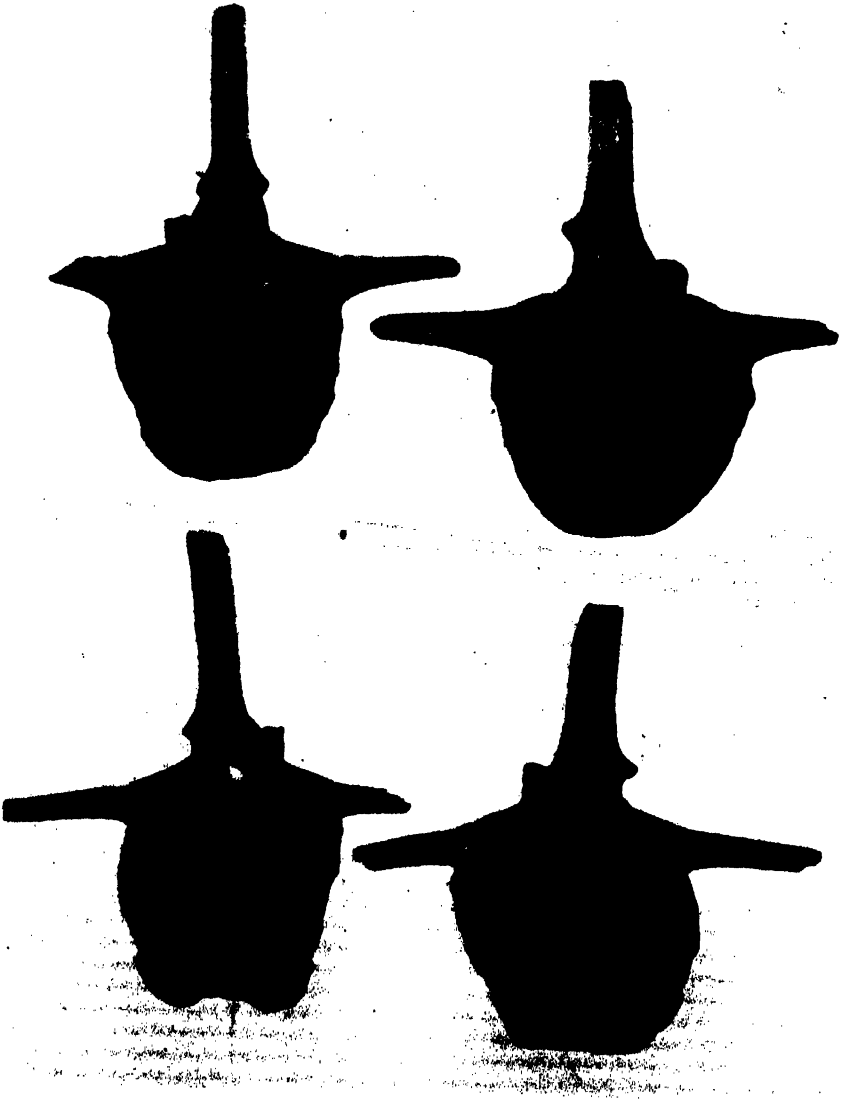

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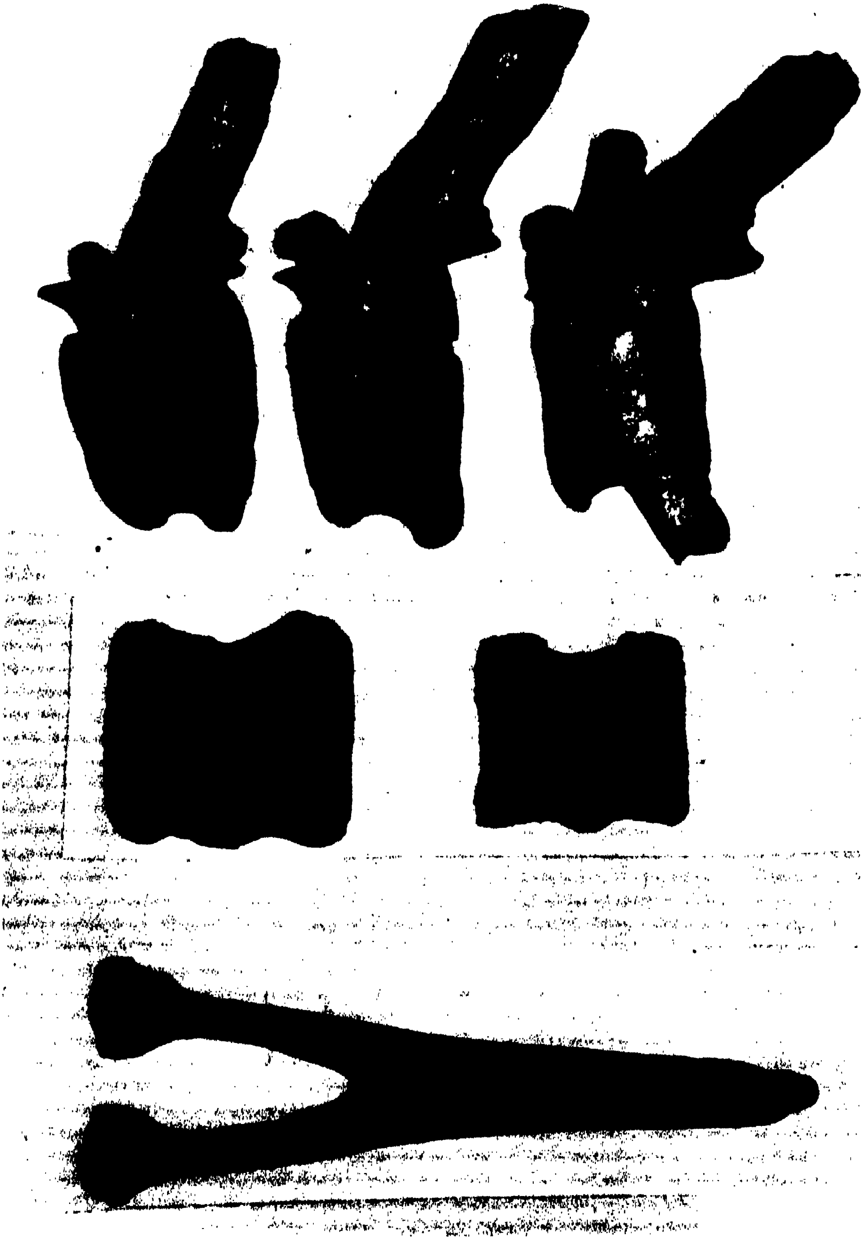

COLBERT: HADROSAURIAN DINOSAUR

STUDIES ON THE SUBSURFACE GEOLOGY AND PALEONTOLOGY OF THE ATLANTIC COASTAL PLAIN

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Introduction

In this report an attempt has been made to gather data from many of the deep water wells and oil tests that have been drilled along the Atlantic Coastal Plain between Long Island and Georgia. It supplements a report previously published by the writer (Richards, 1945). Various types of information have been used in determining the correlations of the various subsurface formations; particular attention has been given to the macrofossils, especially the mollusks. Some of the more important species found in earlier wells have been discussed and figured (Richards, 1947), and some additional species are figured in this report. This paper is largely based on the writer's own studies; however, in some cases it has seemed desirable to quote unpublished information which might not otherwise be available for workers in this field; in these cases suitable credit has been given.

Acknowledgments

This work was aided by a grant from the Penrose Bequest of the Geological Society of America awarded in December, 1942, for a study of samples from wells between New Jersey and Florida; a renewal of this grant was obtained in December, 1944. Acknowledgment to the various individuals who cooperated by supplying samples, well logs, and other information will be found under the discussion of the various states. The assistance of Miss Helen Shoemaker in the sorting of the samples and other laboratory work is also acknowledged. This manuscript was released by the Geological Society of America for publication.

Various oil companies have given information on the oil tests and have in certain instances supplied data on correlation based on studies of microfossils. Several field trips to type localities in the Coastal Plain were made

in collaboration with Dr. W. S. Pike and Miss Doris Malkin of Shell Oil Company, Incorporated; the writer is indebted to the Shell Oil Company for microfaunal data on a few of the wells included in this report.

Thanks are also due to Dr. B. F. Howell for assistance in the identification and discussion of certain of the annelids.

Committee on Geologic Names and Correlations

In October, 1946, while this report was in preparation, the writer was appointed to the committee of Geologic Names and Correlation of the American Association of Petroleum Geologists. In this connection he was asked to help assemble data on the subsurface geology of the Atlantic Coastal Plain; to accomplish this, the cooperation of many geologists will be sought. The present paper does not represent the work of this committee, but can be regarded as a report containing data that will be extensively used in the committee work on the Atlantic Coast. Since the final report of this committee will contain numerous cross-sections as well as some generalized conclusions, only three generalized sections will be included with the present paper. It is probable that some of the well logs used in this paper will also appear in the committee report; however, many additional wells are considered in the present paper.

Location of Samples

Well samples were examined at Jamaica, New York, Trenton, New Jersey, Baltimore, Maryland, Charlottesville, Virginia, Raleigh, North Carolina and Atlanta, Georgia. In many cases, duplicate cuts were deposited at the Academy of Natural Sciences of Philadelphia. In addition, the extensive Woolman Collection of well samples, made between 1890 and 1902, continued to be a source of valuable information. The location of the samples is indicated in the discussion of each well, the following symbols being used:

USGS-J	U.S. Geological Survey, Jamaica, New York
USGS-T	U.S. Geological Survey, Trenton, New Jersey
NJGS	New Jersey Geological Survey, Trenton, New Jersey
LW	Woolman Collection, Academy of Natural Sciences, Philadelphia, Pennsylvania
ANSP	Academy of Natural Sciences, Philadelphia, Pennsylvania
MdGS	Department of Geology, Mines and Water Resources, Baltimore, Maryland
VaGS	Virginia Geological Survey, Charlottesville, Virginia
NCGS	North Carolina Geological Survey, Raleigh, North Carolina
NCSM	North Carolina State Museum, Raleigh, North Carolina
USGS-R	U.S. Geological Survey, Raleigh, North Carolina
GaGS	Department of Mines, Mining and Geology, Atlanta, Georgia
FlaGS	Florida Geological Survey, Tallahassee, Florida

The wells have been numbered consecutively following those of the previous paper (Richards, 1945). Thus, the New Jersey section starts with well number 30, the previous twenty-nine wells of the series having been discussed in the earlier paper.

No attempt has been made to give complete logs of the various wells. The following abbreviations are used in the simplified logs given under the majority of the wells:

bry. = Bryozoa
cl. = Clay
diat. = Diatoms
forams. = Foraminifera
frag. = Fragments
glauc. = Glauconite
gr. = Gravel
ls. = Limestone
peb. = Pebbles; pebbly
s. = Sand
sh. = Shells
ss. = Sandstone

LONG ISLAND (NEW YORK)

While there has been no attempt to make a detailed study of samples from Long Island, a few sets were examined in order to establish a correlation with New Jersey (see text-figure 1). In view of the lack of fossils, it has been very difficult to subdivide the Cretaceous of Long Island. The term " Magothy " formation in current usage by Long Island geologists includes the Cretaceous deposits younger than the Raritan. It is highly probable that this term includes the non-marine equivalent of some formations higher than the Magothy of New Jersey. Many years ago some marine fossils were reported from the Cretaceous on Long Island (Fuller, 1914, p. 78); these suggest an age slightly younger than the Magothy of New Jersey. In this paper the more general term " post-Raritan " will be used.

The writer is indebted to M. L. Brashears and Claude M. Roberts of the U. S. Geological Survey at Jamaica, N. Y., for permission to consult certain specimens and for information on the several wells. A recent paper on the subsurface geology of Long Island including a contour map of the Basement rock has been issued by de Laguna and Brashears (1946).

1. *Barren Island, Kings County, N. Y.* Elev. 5 ft. Depth 740 ft. LW.

0-220 PLEIST.
220-500 UP. CRET. (post-Raritan)
500-740 UP. CRET. (Raritan)

Lloyd sand at the base of the Raritan. See Woolman (1896, pp. 155-7).

2. *Woodhaven, Kings County, N. Y.* Elev. 10 ft. Depth 577 ft. LW. (8 miles NNE Barren Island)

0-213 PLEIST.
213-456 UP. CRET. (post-Raritan)
456-566 UP. CRET. (Raritan)
566-577 BASEMENT COMPLEX

See Woolman (1896, pp. 158-60).

3. *Rockaway Park, Queens County, N. Y.* Elev. 10 ft. Depth 1049 ft. USGS-J.

0- 310	PLEIST.
310- 461	UP. CRET. (post-Raritan)
461- 976	UP. CRET. (Raritan)
976-1031	weathered bed rock
1031-1049	BASEMENT COMPLEX

From driller's log and personal communications by M. L. Brashears and C. M. Roberts.

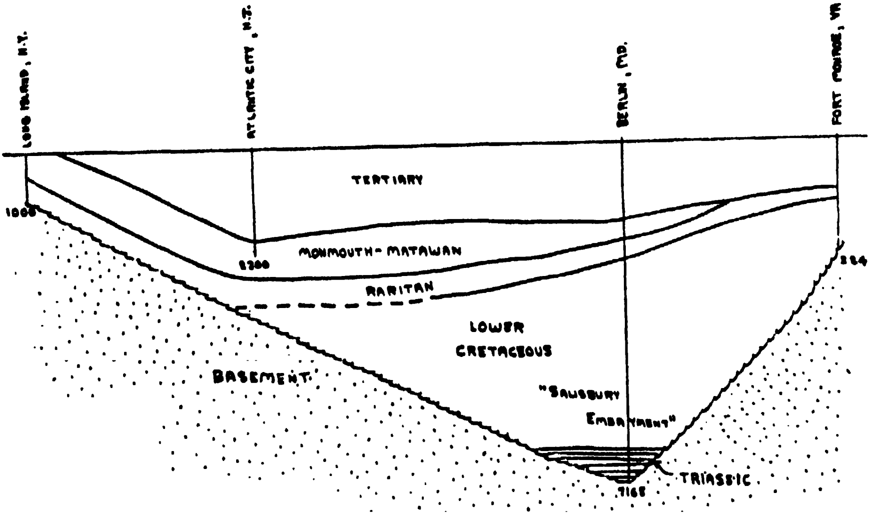

Figure 1.—Generalized section Long Island, N. Y. to Fort Monroe, Va. (Vertical scale 1 inch = 4000 feet; horizontal scale 1 inch = 80 miles.)

NEW JERSEY

Meredith E. Johnson, State Geologist of New Jersey, again cooperated by furnishing us with samples from numerous wells drilled in the state and by supplying information from his extensive files. The Ground Water Division of the United States Geological Survey cooperated by allowing us to consult samples in their office at Trenton, New Jersey. In this connection, we are especially indebted to Henry C. Barksdale, George D. DeBuchananne, and John M. Birdsall. Various local well drillers supplied samples for this study; in this connection, we should especially mention the A. C. Shultes Company of Woodbury, New Jersey, and Layne-New York of Camden, New Jersey.

30. *Runyon, Middlesex County, N. J.* Elev. 7 ft. Depth 440 ft. USGS-T; ANSP. Composite of several wells:

0- 15	iron-stained s.	PLEIST.	Cape May
15-307	s. and cl.	UP. CRET.	Raritan
307-310	red shale	TRIASSIC	Newark
310-440	rock	BASEMENT COMPLEX	

A recent well (1946) was drilled to 267 feet in the Farrington member of the Raritan formation. See Barksdale et al (1943) for discussion of subdivisions of the Raritan of Middlesex County, New Jersey. Data on bed rock from M. E. Johnson.

31. *Spottswood, Middlesex County, N. J.* Elev. 30 ft. Depth 299 ft. USGS-T; ANSP. (Duhernol Water Supply.)

0-299	varicolored s. & cl.	UP. CRET.	Raritan

Basement rock (mica schist) was struck in the immediate vicinity at a depth of 311 feet, according to Johnson (personal communication).

32. *Parlin, Middlesex County, N. J.* Elev. 49 ft. Depth 316 ft. ANSP. Composite log of several wells drilled by Layne-New York Drilling Company:

0-300	varicolored s. & cl.	UP. CRET.	Raritan
300-316	red shale	TRIASSIC	Newark

33. *Old Bridge, Middlesex County, N. J.* Elev. 30 ft. Depth 355 ft. ANSP.

17-311 ±	s. & cl.	UP. CRET.	Raritan
311 ± -355	schist	BASEMENT COMPLEX	Wissahickon

34. *Monmouth Beach, Monmouth Co., N. J.* Elev. 10 ft. Depth 420 ft. NJGS; ANSP. (Monmouth Beach Cold Storage Company.)

0- 15	s.	PLEIST.	Cape May
15- 85	glauc. s.	UP. CRET.	Red Bank
85-115	glauc. s.; cl.	UP. CRET.	Navesink
115-200	glauc. micac. cl.	UP. CRET.	Mt. Laurel
200-235	gray & brown cl.	UP. CRET.	Marshalltown
235-320	glauc. s. & cl.; fossils	UP. CRET.	Englishtown (?)
320-420	s., cl., lignite	UP. CRET.	Englishtown

The cephalopod *Belemnitella americana* (Morton) was found at 260 and 310 feet. This species is characteristic of the Mt. Laurel or Navesink, but could conceivably occur in the Marshalltown or Englishtown formations. No fauna of macrofossils has been reported from the Englishtown formation, although foraminifera and shell fragments have been found in a few wells (Richards, 1945, p. 948). Lignite is abundant in some parts of the Englishtown formation in the Monmouth Beach well.

35. *Neptune Township, Monmouth Co., N. J.* Elev. 80 ft. Depth 475 ft. NJGS; ANSP. (Wardell Dairy; 3 miles west of Bradley Beach.)

0- 40	s and gr.	PLEIST.	Cape May
40- 55	s, few peb.	MIOCENE	Cohansey
55- 85	sandy cl.	MIOCENE	Kirkwood
85-115	light glauc. cl.	EOCENE	Manasquan
115-245	glauc. cl. forams.	EOCENE	Vincentown
245-300	glauc. cl.	EOCENE	Hornerstown
300-395	glauc. s, cl.	UP. CRET.	Red Bank
395-440	cl.	UP. CRET.	Navesink
440-475	glauc. s.	UP. CRET.	Mt. Laurel-Wenonah

Microfossils from this well, especially from the Vincentown formation have been studied by Miss Mary Cameron Vogt, of the Department of Geology and Geography of Mount Holyoke College. The following summary of an unpublished report is from a personal communication and is quoted with her permission:

"As the fauna of the Vincentown formation was of special interest to me, the very fossiliferous samples at depths of 150 and 180 feet were the most intensively studied.

"Only three genera were recognized which are of sufficiently short geologic range to corroborate the Eocene age of the Hornerstown, Vincentown and Manasquan formations. Six of the Neptune Township species have been found in Eocene strata in other parts of the United States. Descriptions of twenty-three foraminifera were not located in the micropaleontological literature, thereby making stratigraphic correlation and age determination difficult. They have been identified as new in my master's thesis for the Department of Geology at Bryn Mawr College.

"Siliceous objects of microscopic size recur throughout most of the horizons. They resemble most closely the Eocene radiolaria from the Mount Diablo area, California."

36. *Interlaken, Monmouth Co., N. J.* Elev. 130 ft. Depth 240 ft. ANSP.

Two samples were received from a well drilled by William Stothoff Company,

170	glauc. and shells (*Etea delawarensis* Gabb)	EOCENE	Manasquan
240	glauc. and bry.	EOCENE	Vincentown

37. *Farmingdale, Monmouth Co., N. J.* Elev. 75 ft. Depth 120 ft. NJGS; ANSP. (Rokeach Cannery)

0- 20	clayey s.	MIOCENE	Kirkwood
20- 45	glauc. s.	EOCENE	Manasquan-Shark River
45-120	glauc. s.	EOCENE	Vincentown

The material from the Vincentown formation was highly fossiliferous, especially between 65 and 70 feet. The following species have been identified:

Polorthus tibialis (Morton)
Teredo irregularis Gabb
Cucullea sp.
Gryphaeostrea vomer (Morton)
Gryphaea sp.
Spirulaea rotula (Morton)
Lamna texana (Shark tooth)
Bryozoa spp.
Echinoderm spines and fragments

38. *Sea Girt, Monmouth Co., N. J.* Elev. 11 ft. Depth 755 ft. LW.

0- 75	s.	PLEIST.	Cape May
75-126	s. cl.	MIOCENE	Cohansey
126-156	s.	MIOCENE	Kirkwood
156-240	glauc. s. cl.	EOCENE	Manasquan-Shark River
240-530	glauc. s. cl.	EOCENE	Vincentown & Hornerstown
530-570	glauc. s.; sh. frag.	UP. CRET.	Navesink
570-700	s.	UP. CRET.	undifferentiated
700-755	s. gr.	UP. CRET.	Englishtown (?)

See original log by Woolman (1895, pp. 75-6). Revisions based on study of lithology and microfaunal evidence.

39. *Island Heights, Ocean Co., N. J.* Elev. 5 ft. Depth 1145 ft. LW.

0- 50	s.	PLEIST.	Cape May
50-365	s. some gr.	MIOCENE	Cohansey and Kirkwood
365-500	glauc. s.	EOCENE	Manasquan
500-700	calc. glauc. marl	EOCENE	Vincentown
700-850	glauc. s.	EOCENE	Hornerstown

Original log by Woolman (1901, pp. 65-8). Revisions based on study of lithology and microfaunal evidence.

40. *Seaside Park, Ocean Co., N. J.* Elev. 10 ft. Depth 510 ft. ANSP. (Shultes well; 1946)

0- 60	s. cl.	PLEIST.	Cape May
60- 87	coarse s., some cl.	PLEIST.	(?)
87-192	white s.	MIOCENE	Cohansey
192-484	mostly s.	MIOCENE	Kirkwood
484-510	blue cl.	MIOCENE	basal Kirkwood

An earlier well (Woolman Collection) shows Eocene (Manasquan?) between 490 and 518 feet.

41. *Cranbury Station, Middlesex Co., N. J.* Elev. 120 ft. Depth 180 ft. NJGS; ANSP.

0- 20	s. fine gr.	PLEIST.	
20- 60	cl.	UP. CRET.	Merchantville
60- 75		(no samples)	
75-100	s.	UP. CRET.	Magothy
100-110	s. cl.	UP. CRET.	Magothy
110-175	s.	UP. CRET.	Magothy
175-180	sandy cl.	UP. CRET.	Magothy

42. *Pemberton, Burlington Co., N. J.* Elev. 50 ft. Depth 147 ft. NJGS; ANSP. (Pemberton Lumber Company)

0- 25	glauc. cl.	EOCENE	Manasquan
25- 75	glauc. cl. & s. bry. & sh. frag.	EOCENE	Vincentown
75- 95	glauc. cl.	EOCENE	Hornerstown
95-120	slightly glauc. cl.	UP. CRET.	Navesink
120-147	s. sh. frag.	UP. CRET.	Mt. Laurel-Wenonah

Fossils

Belemnitella americana (Morton)	123, 130, 140 ft.
Ostrea mesenterica (Morton)	123 ft.
Ostrea falcata (Morton)	130, 140 ft.
Ostrea sp.	70 ft.
Pecten sp.	123 ft.

43. *Wrightstown, Burlington Co., N. J.* Elev. 110 ft. Depth 268 ft. ANSP. (1.5 miles southwest of Cookstown)

0- 60	sandy cl.	MIOCENE	Kirkwood
60-190	s. cl. sh. (*Ostrea bryani* Gabb)	EOCENE	Vincentown & Hornerstown
190-246	cl.	UP. CRET.	
246-254	med. glauc. s.; water	UP. CRET.	
254-268	clayey s.	UP. CRET.	

44. *Paulsboro, Gloucester Co., N. J.* Elev. 8 ft. Depth 277 ft. ANSP. (Layne-New York well)

0-277	s.	UP. CRET.	Raritan
277-	schist	BASEMENT COMPLEX	Wissahickon

45. *Gibbstown, Gloucester Co., N. J.* Elev. 8 ft. Depth 105 ft. USGS-T; ANSP.

0- 35	s. gr.	PLEIST.	Cape May
35-105	cl. s.	UP. CRET.	Raritan

Basement rock was encountered in nearby wells at — 114 feet and — 125 feet (personal communication from M. E. Johnson).

46. *Wenonah, Gloucester Co., N. J.* Elev. 70 ft. Depth 320 ft. USGS-T; ANSP.

0-260	glauc. s. cl.	UP. CRET.	Woodbury & Merchantville
260-320	s. gr.	UP. CRET.	Magothy & Raritan

Well preserved fossil wood at 270 feet.

47. *Pitman, Gloucester Co., N. J.* Elev. 102 ft. Depth 150 ft. ANSP.

A well drilled on the Peterson farm (East Holly Avenue Extension and Delsea Drive) encountered Miocene (Kirkwood) fossils between 40 and 60 feet. The following were identified:

Polinices duplicata Say
Polinices heros Say
Phacoides sp.

48. *Carneys Point, Salem Co., N. J.* Elev. 10 ft. Depth 278 ft. ANSP. (Dupont Powder Plant)

0-278	s. cl. some lignite	UP. CRET.	Raritan
278-	granite	BASEMENT COMPLEX	

There is considerable irregularity in the surface of the basement rock in this area; granite had not been encountered at the depth of 380 feet in a nearby well (Johnson).

49. *Deepwater Point, Salem Co., N. J.* Elev. 5 ft. Depth 408 ft. ANSP. (Dupont Company; 5 miles south Penns Grove)

0-104		(no samples)	
104-239	s. gr.	UP. CRET.	Raritan
239-408	weathered rock	BASEMENT COMPLEX	Wissahickon
408-	rock	BASEMENT COMPLEX	

50. *Woodstown, Salem Co., N. J.* Elev. 50 ft. Depth 674 ft. USGS-T; ANSP. Composite log based on Woolman samples and two recent wells.

0- 30		PLEIST.	
30- 70	glauc. s.	EOCENE	Hornerstown
70- 90		(no samples)	
90-200	s. some glauc.	UP. CRET.	Monmouth group
200-300	micaceous s.	UP. CRET.	Matawan group
300-647	s.	UP. CRET.	Magothy & Raritan

51. *Clarks Mill, Cumberland Co., N. J.* Elev. 30 ft. Depth 110 ft. USGS-T; ANSP. (Dupont Company; 3 miles southeast Millville)

0- 60	s. some gr.	PLEIST.	Cape May
60-110	s.	MIOCENE	Cohansey

52. *Woodbine, Cape May Co., N. J.* Elev. 40 ft. Depth 140 ft. NJGS; ANSP. (State Institution)

0- 50	s. gr.	PLEIST.	Cape May
50-140	sandy cl.	MIOCENE	Cohansey

53. *Tuckahoe, Cape May Co., N. J.* Elev. 20 ft. Depth 128 ft. NJGS; ANSP.

0- 45	s. gr. at bottom	PLEIST.	Cape May
45- 75	sandy cl.	MIOCENE	Cohansey
75-128	fine s.	MIOCENE	Cohansey

The samples from the Cohansey formation of this and the preceding well were examined for microfossils, but none were found.

27.[*] *Atlantic City, Atlantic Co., N. J.* Elev. 5 ft. Depth 2306 ft. LW. (Young's Pier)

The presence of the Jackson coral *Trochocyathus lunulitiformis* (Conrad) at 950 feet, as well as numerous microfossils, suggests the presence of the Jackson Eocene between 950 and 1240 feet instead of the basal Miocene as previously reported (Richards, 1945, p. 896). The revised log follows:

0- 90	PLEIST.	Cape May
90- 126	PLEIST.	Pensauken (?)
126- 390	MIOCENE	Cohansey
390- 950	MIOCENE	Kirkwood
950-1240	EOCENE	Jackson
1240-1440	EOCENE	Manasquan
1440-1900	EOCENE	Vincentown
1900-2150	EOCENE	Hornerstown
	UP. CRET.	Red Bank & Navesink
2150-2306	UP. CRET.	Mt. Laurel-Wenonah

See Richards (1945) for subdivisions of the Kirkwood formation.

28.[*] *Wildwood, Cape May Co., N. J.* Elev. 10 ft. Depth 1244 ft. LW.

In view of the revised correlation of the Atlantic City well, the Wildwood well should also be revised as follows:

0- 132	PLEIST.	Cape May
132- 152	PLEIST.	Pensauken (?)
152- 290	MIOCENE	Cohansey
290-1100	MIOCENE	Kirkwood
1100-1244	EOCENE	Jackson

Jackson microfossils are present below 1100 feet.

28.[*] *Cape May, Cape May Co., N. J.* Elev. 10 ft. Depth 1313 ft. LW.

Similarly, the correlation of this well should be revised as follows:

0- 90	PLEIST.	Cape May
90- 140	PLEIST.	Pensauken (?)
140- 310	MIOCENE	Cohansey
310- 990	MIOCENE	Kirkwood
990-1313	EOCENE	Jackson

DELAWARE

6. *Milford, Sussex Co., Del.* Elev. 30 ft. Depth 770 ft.

0- 42	s. gr.	PLEIST.	Cape May
42- 87	clayey s.	MIOCENE	Cohansey
87-724	s. cl. sh.	MIOCENE	Kirkwood
724-770	glauc. s. cl.	MIOCENE	Kirkwood (?)

The following mollusks were identified between 204 and 223 feet:

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[*] Revision of log in previous (1945) report.

Venus mercenaria Linné
Astarte undulata vaginulata Dall
Astarte symmetrica Conrad
Dosinia acetabulum Conrad
Turritella cumberlandia Conrad
Pecten madisonius Say
Melina maxillata Deshayes

The greensand between 724 and 770 feet is tentatively referred to as the Kirkwood, although it is possible that it is the equivalent of the Jackson deposits in the wells at Atlantic City, Wildwood, Cape May and Brandywine Lighthouse, New Jersey.

7. *Seaford, Sussex Co., Del.* Elev. 27 ft. Depth 666 ft. (Dupont Company)
Composite of several wells; all closely spaced.

0-75	s. cl. a little gr.	PLEIST.	Cape May
75-212	silty cl. s.	MIOCENE	Cohansey
212-666	s. cl. sh.	MIOCENE	Kirkwood

Typical Kirkwood fossils were found, including *Pecten madisonius* Say, *Turritella variabilis* Conrad, *Phacoides crenulatus* (Conrad) and *Balanus* sp.

8. *Lewes, Sussex Co., Del.* Elev. 8 ft. Depth 162 ft. USGS-T. (Test well)

0-86	s. peb.	PLEIST.	Cape May
86-162	yellow s., few peb.	MIOCENE	Cohansey

9. *Rehoboth, Sussex Co., Del.* Elev. 10 ft. Depth 114 ft. USGS-T. (Test well)

0-85	s. cl. sh. frag.	PLEIST.	Cape May
85-114	s. few peb.	MIOCENE	Cohansey

MARYLAND

Samples from the three oil tests were furnished through the cooperation of The Ohio Oil Company, Socony-Vacuum Oil Company and Standard Oil Company (New Jersey).

3.* *Chestertown, Kent Co., Md.* Elev. 22 ft. Depth 1135 ft. LW.

See Clark et al. (1918, pp. 220-1; Richards, 1945, p. 901). After further study of the incomplete set of samples, the following correlation is proposed:

0-30	s.	PLEIST.	Cape May
30-180	s. sh. glauc.	EOCENE	Aquia
180-300	s., cl. some glauc.	UP. CRET.	Monmouth
300-330	s., cl.	UP. CRET.	Matawan
330-581	cl. fine s.	UP. CRET.	Magothy-Raritan
581-955	cl. a little s.	LOWER CRET.	Patapsco
955-1135	cl.	LOWER CRET.	Patuxent

19. *Centerville, Queen Anne Co., Md. Elev. 59 ft. Depth 655 ft. LW.*

0- 25	s. cl. sh.	RECENT & PLEIST.	
25-170	s. cl. sh.	MIOCENE	Chesapeake
170-356	s. glauc.	EOCENE	Vincentown (?)
356-370	glauc. sh.	EOCENE	Hornerstown
370-655	glauc. cl.	UP. CRET.	

Terebratula harlani Morton and *Gryphaea dissimilaris* Weller at 356-370 feet; *Exogyra* sp. at 370 feet.

18.[*] *Salisbury, Wicomico Co., Md.* Elev. 57 ft. Depth 5563 ft. ANSP; MdGS. (The Ohio Oil Company's L. G. Hammond No. 1; 6 miles east of Salisbury)

Stephenson (1946) regards the shell bed between 1588 and 1603 as Raritan-Tuscaloosa in age instead of Matawan as suggested by the writer (1945, p. 903; 1945a).

A revised correlation would be as follows:

0- 100	PLEIST.	Wicomico
100- 320	MIOCENE	Cohansey
320- 540	MIOCENE	Kirkwood
540- 620	MIOCENE	Choptank
620-1160	MIOCENE	Calvert
1160-1200	EOCENE	Jackson
1200-1380	EOCENE	Pamunkey (and Midway?)
1380-1500	UP. CRET.	Monmouth-Matawan
1500-2300	UP. CRET.	Magothy-Raritan
2300-5360	LOWER CRET.	Potomac
5360-5529	TRIASSIC	Newark
5529-5563	BASEMENT COMPLEX	

20. *Berlin, Worcester Co., Md.* Elev. 45 ft. Depth 7168 ft. ANSP; MdGS. (Socony-Vacuum Oil Company's Bethards No. 1; 4.5 miles southwest of Berlin)

40- 100	PLEIST.	Cape May
100- 791	(no samples.)	
791-1100	MIOCENE	Chesapeake
1100-1270	(no samples)	
1270-1710?	EOCENE	
?1710-1890	UP. CRET.	Monmouth and Matawan
1890-....	UP. CRET.	Magothy and Raritan
....-6486	LOWER CRET.	Potomac
6486-7157	TRIASSIC	Newark
7157-7168	BASEMENT COMPLEX	

Comments

1. Shell fragments in the 40-100 foot samples are assigned to the marine Talbot formation = Cape May.

2. Diatomaceous clay between 930 and 1100 correlates with the " Great Diatom Bed " of the New Jersey Miocene.

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[*] Revision of log in previous (1945) report.

3. No macrofossils in the Eocene; upper limit impossible to determine because of the missing samples.

4. The separation between the Monmouth and Matawan groups is indistinct, and therefore the two groups are combined in the above correlation.

5. There is a conspicuous shell zone between 1980 and 2060 feet which is probably equivalent to the shell zone in the Hammond well near Salisbury between 1568 and 1618 feet. Stephenson (1946) regards this bed as part of the Raritan formation. *Corbula whitei* Richards is common in both beds.

6. Shells were found in many cuttings below 2060 feet, but it is thought that they were carried down from above. The cuttings were uniformly poor.

7. The Upper Cretaceous to the depth of 2060 feet contains more marine fossils than in the similar section of the Ohio Company's Hammond well.

8. The Magothy, Raritan and Potomac formations are largely nonmarine, although a few shell zones such as the one between 1980 and 2060 occur in the Raritan. These formations are difficult to separate.

9. Indeterminable fragments of foraminifera were found in the cores at 2735-51, 3155-77, and 4213-28 feet. These suggest a temporary marine advance during the deposition of the formations of the Potomac group.

10. The Triassic is 671 feet thick in this well as compared with only 169 feet in the Hammond well at Salisbury.

11. The " basement " is an igneous black rock, probably a gabbro.

21. *Sparrow's Point, Baltimore Co., Md.* Elev. 8 ft. Depth 344 ft. MdGS. (Test Well #1)

0-118 s.	PLEIST	Talbot = Cape May
118-328 s.	LOWER CRET.	Patapsco
328-344 cl.	LOWER CRET.	Arundel

The samples from this well were examined through the kindness of Mr. Robert Bennett of the U.S. Geological Survey at Baltimore. The above correlation is based on a preliminary report prepared by Bennett (1945). Shells of ***Rangia cuneata*** Gray were observed in the Pleistocene and some unidentifiable fragments in the Patapsco.

23. *Ocean City, Worcester Co., Md.* Elev. 13 ft. Depth 7710 ft. ANSP. (Standard Oil Company of New Jersey's Maryland Esso No. 1; 5 miles north of Ocean City.)

0- 100	PLEIST. Talbot = Cape May; marine fossils
100- 112	PLEIST. Wicomico ? (gravel; non-marine)
112- 570	MIOCENE Cohansey
570-1595	MIOCENE Chesapeake group (many fossils)
1595-2080	EOCENE
2080-2354	UP. CRET. Monmouth-Matawan (= Navarro-Taylor)
2354-2734	UP. CRET. Magothy (= Austin)
2734-5400	UP. CRET. Raritan LOWER CRET. Patapsco and Arundel
5400-6978	LOWER CRET. Patuxent
6978-7710	LOWER CRET. ? Patuxent ?

The above correlation is based on information supplied by Walter B. Spangler, of the Standard Oil Company of New Jersey, plus an examination of the samples by the present writer.

The first specimen of *Hamulus onyx* Morton, a good Upper Cretaceous marker was found at 2230 feet.

The Upper-Lower Cretaceous boundary is very indistinct. Standard Oil geologists tentatively place the Patapsco and Arundel formations of the Potomac group, previously regarded as Lower Cretaceous, with the Raritan of Upper Cretaceous age, the Patuxent formation alone being regarded as of Lower Cretaceous age. At any rate, they are exceedingly difficult to separate, and are combined in the above correlation.

The samples between 6978 and the bottom of the well are questionably referred to the Triassic by Standard Oil geologists. According to Mr. Spangler, " their electric log characteristics and lithology are similar to beds in the Bethards and Hammond wells that were referred to the Triassic on the basis of lithology. These beds in all three wells may be of Lower Cretaceous age and more definite evidence is needed before any true age assignment can be given them."

A study of the samples by the present writer suggests that the material below 6978 feet in the Ocean City well is not as consolidated as the material referred to the Triassic in the other two Maryland wells. Therefore, the writer tentatively refers this section to the Lower Cretaceous.

The following notes on the microfossils were supplied by Mr. Spangler and are quoted with the permission of the Standard Oil Company of New Jersey:

" 1650 feet	Beginning of Eocene type microfauna suggesting Jackson age;
1820	Beginning of highly fossiliferous zone carrying microfaunas, some forms suggesting Midway age;
2010	Beginning of fossiliferous section carrying forms usually noted in the basal Midway of the Gulf region;
2080-2360	Fauna at top of section similar to Saratoga-Taylor, Upper Selma of Gulf region;

2360	Beginning of section lithologically like Eutaw of Gulf region. (Contains microfauna, some forms common to beds assigned to the Eutaw in North Carolina wells.)
2734	First occurrence of siderite pellets. These pellets have not been noted above the Raritan-Tuscaloosa in wells along the East Coast and have been used in the Gulf Region as criteria for picking the top of the Tuscaloosa."

Macrofossils were not very abundant in the small samples examined by the writer, so the following notes do not represent an exhaustive study of the well.

1. Characteristic Miocene fossils were found between 570 and 1595 feet. Because of the small samples obtained, no attempt has been made to separate the various formations of the Chesapeake group.

2. One core containing excellent macrofossils was obtained between 4875 and 4885 feet, and was sent by Standard Oil Company of New Jersey to the U.S. National Museum, where it will probably be studied.

3. Fossils, frequently fragmental, were found in many samples from the Cretaceous formations, but only a few have been identified specifically. The following were the most conspicuous:

Hamulus onyx Morton	2230 ft. and other depths.	(Plate 9, fig. 9.)
Ostrea sp.	3180-90 ft.	
Nuculana sp.	4230-40 ft.	(Plate 9, fig. 15.)
Pecten sp.	4885-90 ft.	
Ammonite[1]	5670-80 ft.	
Plicatula ? sp.	7510-20 ft.	(Plate 9, fig. 14.)
Ostrea sp.	7510-20 ft.	
Turritella sp.	7650-60 ft.	(Plate 9, fig. 11.)

Salisbury Embayment

The three recent oil tests drilled near Salisbury, Berlin and Ocean City, Maryland, demonstrate that the " basement " is deeper in this area than either to the north or south. Without further drilling or complete geophysical data it is impossible to define the accurate limits of this " low " area. Nevertheless it is clear that the basement rock rises from 5529 feet at Salisbury and 7157 feet at Berlin to 2320 feet at Matthews, Virginia and 2254 feet at Fort Monroe, Virginia.

The rise of the basement toward the north is more difficult to determine because of the lack of wells to bed rock. However, the thinness or absence of the Lower Cretaceous beds under New Jersey may be taken as an indication of a rise in the basement. Furthermore, geophysical investigations

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[1] "The present fragment might, with some reservation, be identified as *Scaphites* aff. *warreni* Meek and Hayden . . . *S. warreni* occurs in the Upper Turonian Carlile shale. The specimen examined might, thus, most likely be of early Upper Cretaceous, perhaps Turonian age." (Personal communication from Dr. Otto H. Haas, American Museum of Natural History, New York.)

(Woollard, 1941) indicate a basement at a depth of about 4592 feet at Woodbine, New Jersey, suggesting a considerable rise from 7157 feet at Berlin, Maryland.

This " low " area can be traced westward to Meadows, Maryland, only about 13 miles east of outcroppings of basement rock in Washington, D. C. A well drilled near Meadows in 1918 was still in the Patuxent formation at 1522 feet with basement probably not far below this point.

It is proposed that this region of steeply sloping basement be called the " Salisbury Embayment." It roughly extends from Washington, D. C. through Meadows, Salisbury, Berlin and Ocean City, Maryland, and thence eastward beneath the present ocean. Its north and south limits cannot be accurately determined at present, but it is estimated that the embayment is about 75 miles in width.

Shales and sandstones tentatively referred to the Triassic (Newark group) have been found in two of the wells in this embayment as follows:

Salisbury	5360-5529 feet
Berlin	6486-7157 feet

The thickness of Cretaceous beds in this basin is considerably greater than either north or south of the region. It is possible that some of the beds here assigned to the Lower Cretaceous may actually be of Jurassic age, although in the absence of fossils this cannot be determined. It is probable that this basin existed during Triassic time and that there may have been a connection to the open ocean to the east. Deposition was probably more or less continuous in this embayment throughout Lower and Upper Cretaceous time, and possibly from the Jurrassic. Salt water moved in and out of the embayment at various times as demonstrated by the zones of marine fossils in the Lower and Upper Cretaceous formations dsposited in the embayment. Since deposition was more or less continuous, it is difficult to separate the various formations of the Potomac group (Lower Cretaceous) and the Raritan and Magothy formations (Upper Cretaceous).

The presence of Triassic rocks in a well at Bowling Green, Caroline County, Virginia, may indicate part of the same basin, or possibly a separate depressed region. (Richards, 1945 p. 909).

The Salisbury Embayment may represent an ancient estuary, possibly an ancestor of Chesapeake Bay or the Potomac River; on the other hand, it may represent a fault.

Geophysical evidence supports the existence of this embayment (Balsey et al., 1946), but does not give any definite clue as to its origin. Ewing et al. (1946 p. 918) report that seismic studies in Chesapeake Bay near Solomons, Maryland, indicate a depth to basement of approximately 3000 feet. This figure is in approximate agreement with that obtained on the

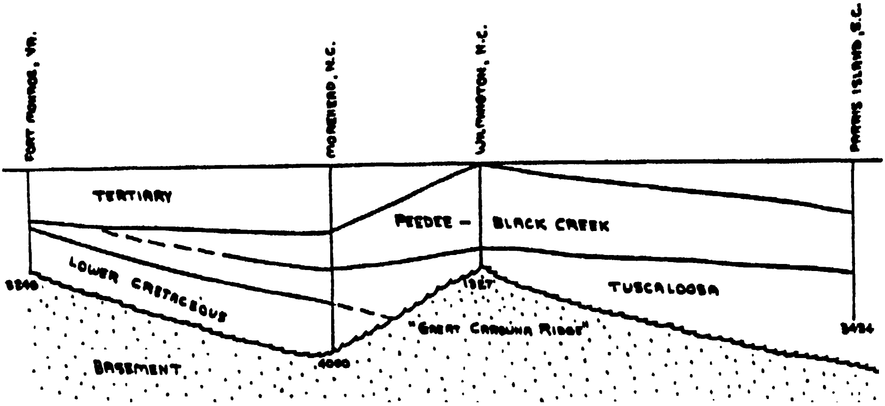

Figure 2.—Generalized section Fort Monroe, Va. to Parris Island, S. C. (Vertical scale 1 inch = 4000 feet; horizontal scale 1 inch = 100 miles.)

assumption of a constant slope from the Fall Line to the Hammond well near Salisbury.

VIRGINIA

The Virginia Geological Survey continued to cooperate by supplying certain samples from wells drilled in that state. In addition, considerable material was examined in the office of the Survey in Charlottesville, Virginia. D. J. Cederstrom, of the U. S. Geological Survey, working in cooperation with the Virginia Geological Survey, spent some time in the field with the writer and supplied him with considerable data on the subsurface geology of Virginia. Two manuscripts by Cederstrom on the ground water and geology of Coastal Plain Virginia are now in press. One of these, Bulletin 63, was intended for publication in 1945, and as such was cited in the bibliography of the previous report (Richards, 1945, p. 954). It is hoped that the bulletin will appear this year. Much of the information contained in these reports was summarized in a paper presented before the Virginia Academy of Science on May 9, 1947 (Cederstrom 1947); the present author has used certain of the information given in that report.

3a.* *Newport News, Warwick Co., Va.* Elev. 12 ft. Depth 1082 ft. VaGS; ANSP. (Gas Works)

A restudy of the samples from this well suggests that the Eocene is not as thick as originally supposed (Cederstrom, 1945a; Richards, 1945, p. 905). The following revised correlation is proposed:

0- 34	PLEIST.	
34- 403	MIOCENE	Chesapeake
403- 634	EOCENE	
634-1082	CRETACEOUS	(Upper and Lower)

3.* *Fort Monroe, Elizabeth City Co., Va.* Elev. 10 ft. Depth 2254 ft. VaGS. (Government well of 1902)

0- 50	PLEIST.	
50- 610	MIOCENE	Chesapeake
610- 720	EOCENE	Jackson
720-1000	EOCENE	Nanjemoy
1000-1100	EOCENE	Aquia
1100-2246	LOWER CRET.	(Potomac) possibly including some UP. CRET.
2246-2254	BASEMENT COMPLEX	

The above correlation was based on data given by Cederstrom (1947). While the Eocene is not as thick as originally supposed (Cederstrom, 1945), there is a considerable thinning between the north and south sides of the James River. (See text-figure 2.) This may be due to a fault as suggested by Cederstrom (1945).

23. *Fairview Beach, King George Co., Va.* Elev. 36 ft. Depth 188 ft. VaGS; ANSP. (Three miles below mouth of Potomac Creek)

10- 35	s. & cl.	EOCENE	Nanjemoy
35-188	s. cl. sh. frag.	EOCENE	Aquia

24. *Port Conway, Essex Co., Va.* Elev. 190 ft. Depth 562 ft. VaGS; ANSP. (Pickle Factory)

0-196	cl. sh.	MIOCENE	Chesapeake
196-295	s. rock layers	EOCENE	Nanjemoy
295-377	s. cl.	EOCENE	Aquia
377-562	cl.	UP. CRET.	Raritan (?) unfossiliferous

25. *Tappahannock, Essex Co., Va.* Elev. 30 ft. Depth 550 ft. VaGS; ANSP. (Fair Grounds; 2 miles west of town)

0- 20	clayey s.	PLEIST.	
20- 95	blue cl.	MIOCENE	Chesapeake
95-272	cl. rock streaks	EOCENE	Nanjemoy
272-415	cl.	EOCENE	Aquia
415-550	mottled cl.	UP. CRET. LOWER CRET.	Raritan (?)

26. *West Point, King William Co., Va.* Elev. 13 ft. Depth 729 ft. VaGS.

0-175		(no samples)	
175-197	blue marl	MIOCENE	Chesapeake
197-300	glauc. cl.	EOCENE	Nanjemoy
300-400	glauc. cl.	EOCENE	Aquia
400-729	mottled cl.	CRETACEOUS	

27. *Franklin, Southampton Co., Va.* Elev. 20 ft. Depth 604 ft. VaGS; ANSP. (Layne-Atlantic well of 1944)

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* Revision of log in previous (1945) report.

0- 18	s.	PLEIST.	
18- 57	s. sh.	MIOCENE	Chesapeake
57-174	s. glauc. sh.	EOCENE	Pamunkey (undifferentiated)
174-250	cl.	UP. CRET.	Raritan (?)
250-604	s. cl.	LOWER CRET.	Potomac

The fossiliferous Tuscaloosa (=Raritan) and Midway zones reported from other Franklin wells (Richards, 1945) were not found in this well. *Gryphaeostrea vomer* (Morton) is abundant in the Pamunkey formation.

9.* *Yorktown, York Co., Va.* Elev. 80 ft. Depth 620 ft. VaGS. (Naval Mine Depot)

0- 50	PLEIST.	
50-380	MIOCENE	Chesapeake
380-450	EOCENE	Jackson
450-620	EOCENE	Pamunkey

28. *Kilmarnock, Lancaster Co., Va.* Elev. 89 ft. Depth 740 ft. VaGS; ANSP.

0- 67	sandy cl.	PLEIST.	
67-350	cl. sh.	MIOCENE	Chesapeake
350-420	cl. forams.	EOCENE	Jackson
420-540	cl. s.	EOCENE	Nanjemoy
540-580	cl. s.	EOCENE	Aquia
580-740	s. sandy cl.	UP. CRET.	Raritan (?)

29. *Irvington, Lancaster Co., Va.* Elev. 6 ft. Depth 742 ft. VaGS.

0- 27	s. gr.	PLEIST.	
27-360	cl. sh.	MIOCENE	Chesapeake
360-400	cl. glauc.	EOCENE	Jackson
400-540	s. cl. glauc.	EOCENE	Nanjemoy
540-600	s. cl. glauc.	EOCENE	Aquia
600-742	s. cl.	UP. CRET.	

30. *Calleo, Northumberland Co., Va.* Elev. 101 ft. Depth 356 ft. VaGS.

0-327	cl. sh.	MIOCENE	Chesapeake
327-356	cl. rock layers	EOCENE	Nanjemoy

31. *Colonial Beach, King George Co., Va.* Elev. 20 ft. Depth 634 ft. VaGS; ANSP.

30-200	s. cl.	EOCENE	Nanjemoy
200-320	s. cl. glauc.	EOCENE	Aquia
320-634	s. mottled cl.	UP. CRET.	Raritan (?)

James River Fault

Cederstrom (1945) has postulated the existence of a fault in the basement rock in the James River area. Evidence for this is found in the greater thickness of the Eocene deposits north of the James River as contrasted with south of that river. Geophysical evidence is cited by Cederstrom to support the existence of this fault.

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* Revision of log in previous (1945) report.

Further drilling and geophysical work will have to be done before the existence of this fault can be conclusively demonstrated. It is possible that this fault represents the southern limit of the "Salisbury Embayment," although it seems too far south for this. Or, it may represent a similar embayment formed by an ancestral James River. At any rate, it is obvious that the basement rock is not the smooth gently sloping surface that it was once thought to be.

NORTH CAROLINA

Samples were examined through the cooperation of J. L. Stuckey, State Geologist, and information was provided by M. J. Mundorff, of the Ground Water Division of the U. S. Geological Survey in Raleigh, N. C. Standard Oil Company (New Jersey) through K. D. White and Walter B. Spangler, provided samples and information on their two tests in Dare County, North Carolina. Roderick Stamey, of the Carolina Petroleum Company, supplied samples and information on their tests in Carteret County, North Carolina. Samples from the Camp Lejeune water well were contributed by James D. McLean, Jr.

8a.* *Elizabeth City, Pasquotank Co., N. C.* Elev. 10 ft. Depth 1207 ft. (Sydnor Pump and Well Company; 1916)

Log obtained from Sydnor Company; no samples available. Correlation by M. J. Mundorff and the writer.

0- 493	MIOCENE	Yorktown
493- 542	MIOCENE	Trent
542- 750	EOCENE	Castle Hayne and older
750- 865	UP. CRET.	Peedee and Black Creek
865-1207	UP. CRET.	Tuscaloosa

45. *Eure, Gates Co., N. C.* Elev. 30 ft. Depth 180 ft. NCGS; ANSP. (Parker Farm; 1.5 miles NW of Eure)

0- 68	s. cl. sh. wood	MIOCENE	Yorktown
68-157	green and black s.	EOCENE	Middle (?)
157-180	varicolored cl.	UP. CRET.	Tuscaloosa

46. *Redoco, Gates Co., N. C.* Elev. 30 ft. Depth 315 ft. NCGS; ANSP. (Tinkham Farm)

285-315 cl. UP. CRET. Tuscaloosa

47. *2¾ mi. NE of Gatesville, Gates Co., N. C.* Elev. 33 ft. Depth 600 ft. NCGS; ANSP. (Prison Camp)

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* Revision of log in previous (1945) report.

0- 20	sandy cl.	PLEIST.	
20-164	s. and cl.	MIOCENE	Yorktown
164-245	green & black s.	EOCENE	Middle (?)
264-600	s. and cl.	UP. CRET.	Tuscaloosa

48. *Washington, Beaufort Co., N. C.* Elev. 15 ft. Depth 210 ft. NCGS; ANSP. (Airport)

0- 35	clayey s.	PLEIST.	
35-160	s. cl. sh.	MIOCENE	(Yorktown)
160-170	sandy cl. sh. frag.	EOCENE	Castle Hayne (?)
170-210	s. glauc.	EOCENE	Middle (?)

No Trent (Lower Miocene) was noted in this well as contrasted with a previous well (No. 17) at Washington. (Richards, 1945, p. 912).

49. *Fountain, Pitt Co., N. C.* Elev. 105 ft. Depth 193 ft.

0- 20	PLEIST.	
20- 88	MIOCENE	Yorktown
88-193 ±	UP. CRET.	Tuscaloosa (?)
± 193-	BASEMENT COMPLEX	

After Mundorff (1944). Both east and west of Fountain " basement rock " (granite) is about 400 feet deep, whereas, in the town of Fountain there is a granite quarry, indicating a " hill " in the basement.

50. *Morehead City, Carteret Co., N. C.* Elev. 17 ft. Depth 4044 ft. ANSP. (F. L. Karsten-Laughton No. 1)

This well was drilled as a " farm-out " from Coastal Plains Oil Company in 1945.

0- 140	PLEIST.	Pamlico
	PLIOCENE	Croatan
140- 320	MIOCENE	Yorktown
320- 718	MIOCENE	Trent
718-1450 ±	EOCENE	Castle Hayne and older
± 1450-1700	UP. CRET.	Peedee
1700-2263	UP. CRET.	Black Creek (including Eutaw)
2263-2900 ±	UP. CRET.	Tuscaloosa
± 2900-4036	LOWER CRET.	
4036-4044	BASEMENT COMPLEX	

Comments

1. Pleistocene, Pliocene and Upper Miocene (Yorktown) difficult to separate.

2. Trent and Castle Hayne fairly distinct; determination based on fragments of macrofossils and lithology.

3. Division between Peedee and Black Creek very indistinct.

4. The lower part of the Black Creek is probably equivalent to the Eutaw of the Gulf Coast and the Magothy of New Jersey.

5. The Tuscaloosa is definitely marine, shells being found in both cuttings and cores. There are also foraminifera and ostracods.

6. The ostracods below 2850 feet possibly indicate the Lower Cretaceous (=Washita) according to Mr. Fred M. Swain (personal communication).

7. Although no samples of "basement" were observed by the writer, J. L. Stuckey, State Geologist, and H. T. Davis, of the State Museum, report igneous rock 4036 and 4044 feet. Basement is also indicated on the electric log.

8. The difference in depth to basement between this and the Havelock well (Well No. 20 of previous report; basement at 2318 feet) is interesting. The basement may slope more rapidly east of Havelock; or, Havelock may represent a "high" in the basement, similar to Fountain, and the Karsten well, a "low". The two wells are about 13 miles apart.

51. *Merrimon, Carteret Co., N. C.* Elev. 15 ft. Depth 4072 ft. ANSP. (Carolina Petroleum Company's Guy Carraway No. 1)

0- 220	PLEIST. & MIOCENE	(Yorktown)
220- 510	MIOCENE	Trent
510-1085	EOCENE	Castle Hayne & older
1085-1835	UP. CRET.	Peedee
1835-2210	UP. CRET.	Black Creek
2210-3000 ±	UP. CRET.	Tuscaloosa
± 3000-4053	LOWER CRET.	
4053-4072	BASEMENT COMPLEX	

This well was drilled during 1946. The above correlation is based on a preliminary study of the samples and on information supplied by Roderick Stamey of the Carolina Petroleum Company.

The Carolina Petroleum Company drilled four additional wells in Carteret County in 1946 and during the first part of 1947 drilled one well in Craven County and three in Pamlico County. While the samples from these wells have not yet been fully studied, the following information on the basement rock is available:

Date	County	Location	Name	Elev.	Total Depth	Depth to Basement
1946	Carteret Co.	2 mi. SE of Merrimon	Nita Carraway No. 1	15	4126	4120
1946	Carteret Co.	1½ mi. N. of Merrimon	Phillips-State No. 1	13	3964	3946
1946	Carteret Co.	1½ mi. N of Merrimon	H. B. Salter No. 1	13	3963	3954
1946	Carteret Co.	1 mi. E of Phillips-State well	John Wallace No. 1	11	4024	4015
1947	Pamlico Co.	1 mi. SW of Pamlico	N. C. Pulpwood No. 1	11	3667	3658
1947	Pamlico Co.	1½ mi. NW of N.C. Pulpwood well	Atlas Plywood No. 1	11	3430	3417
1947	Pamlico Co.	1 mi. E of Merritt	Linley No. 1	16	2897	
1947	Craven Co.	1 mi. E of Ellis Lake	Bryan No. 1	21	2435	

52. *Cape Hatteras, Dare Co., N. C.* Elev. 24 ft. Depth 10,054 ft. ANSP; NCSM. (Standard Oil Company of New Jersey's North Carolina Esso No. 1; near Hatteras Light.)

This well, the deepest test yet drilled along the Atlantic Coastal Plain, was commenced December 1, 1945, and completed July 19, 1946.

The following correlation is taken from Swain (1947) who has studied the microfossils, especially the ostracods, from the samples.

0- 180	PLEIST. and PLIOCENE	
180- 995	MIOCENE	(middle and upper)
995-1600	MIOCENE	Trent
1600-1738	OLIGOCENE	(?)
1738-2200?	EOCENE	Castle Hayne
?2200-3034	EOCENE	Claiborne and Wilcox
3034-3147	UP. CRET.	Peedee
3134-3660	UP. CRET.	Black Creek
3660-4288	UP. CRET.	Magothy
4288-4800	UP. CRET.	Eagle Ford
4800-6584	UP. CRET.	Tuscaloosa ?
6584-8500	LOWER CRET.	Early Washita and Fredericksburg
8500-9150	LOWER CRET.	Trinity
9150-9878	LOWER CRET.	Pre-Trinity; Coahuila ?

53. *Pamlico Sound, Dare Co., N. C.* Elev. 21 ft. Depth 6410 ft. ANSP. (Standard Oil Company's North Carolina Esso No. 2; 11 miles south of Wanchese, Roanoke Island.)

This well was drilled in about five feet of water from a submerged barge in Pamlico Sound. Drilling started January 7, 1947, and was abandoned March 13, 1947. The following section is taken from Swain (1947) who has made a study of the ostracods and other microfossils.

0- 230?	PLEIST. and PLIOCENE	
?230-1265	MIOCENE	
1265-1420	OLIGOCENE	
1420-1730	EOCENE	Castle Hayne
1730-2224	EOCENE	Claiborne and Wilcox?
2224-2525?	UP. CRET.	Peedee
?2525-2760	UP. CRET.	Black Creek
2760-3515?	UP. CRET.	Magothy?
3515-3890	UP. CRET.	Eagle Ford
3890-5495	UP. CRET.	Tuscaloosa?
5495-6410	LOWER CRET.	Early Washita and Fredericksburg

The following comments are made after the writer's examination of the samples:

1. There is a thick layer of Miocene (Yorktown) shells between 300 and 400 feet.

2. *Hamulus onyx* Morton occurred at 2810 feet. (Plate 9, fig. 4.)

3. Tubes of the worm *Filograna socialis* (Goldfuss) were found in the sample from 2810 feet. (Plate 9, fig. 16.) As far as can be determined,

this is the first record of this genus from America, although it is known from the Jurassic and Cretaceous of Europe. The North Carolina tubes are slightly smaller than specimens in the Academy's collections from the Jurassic near Urach, Wurtemburg, Germany. They are identical with specimens of Lower Cretaceous age (Neocomian) from Beaudrecourt, France. The North Carolina specimen is of Upper Cretaceous age, and probably from the Magothy formation. This species has been figured as *Serpula socialis* in Zittel's textbook.

4. Numerous specimens of *Hamulus protoonyx* Richards (Plate 9, figs. 3, 8) were present in the Tuscaloosa formation between 3960 and 4900 feet. This is apparently an index fossil for this formation.

5. *Exogyra woolmani* Richards was also present in the Tuscaloosa formation, and was especially common between 4090 and 4110 feet. (Plate 9, fig. 7). This species was described from the Raritan formation (= Tuscaloosa) in a well at Norfolk, Virginia.

6. Other fossils from the Tuscaloosa formation included: *Gryphaea convexa* Say at 4160-70 feet, and *Ostrea* sp. at 5030-40 feet. (Plate 9, Fig. 12.)

54. *Lumberton, Robeson Co., N. C.* Elev. 140 ft. Depth 405 ft. NCGS; ANSP.

0- 20	cl.	PLEIST.	
20-185	s. sh.	MIOCENE	Duplin-Yorktown
185-250		(no samples)	
250-405	varicolored s. & cl.	UP. CRET.	Tuscaloosa

55. *Camp Lejeune, Onslow Co., N. C.* Elev. 25 ft. Depth 95 ft. ANSP. (Junction of Spring and Northeast Creek)

0-40	sandy cl.	PLEIST.	
40-60	fine s.	MIOCENE	Trent (?)
60-95	ls.	OLIGOCENE (?)	

Samples received through the courtesy of James McLean, Jr., who has prepared a report on the microfossils. According to McLean (1947) the fauna between 60 and 95 feet suggests an Oligocene age.

Slope of Basement Rock

Recent drilling in eastern North Carolina has demonstrated that there is a decided increase in the eastward slope of the basement rock. The slope from the Fall Line to approximately Havelock, Craven County, averages about 14 feet per mile, while from New Bern to Cape Hatteras it is about 122 feet per mile. These two slopes are shown graphically by Prouty (1946) and Berry (1948). Prouty has tentatively referred the more gentle sloping plane to the Schooley Peneplane and the steeper one to the Fall Zone Peneplane.

That at least the more gently sloping plane is somewhat irregular is shown by the presence of the granite "hill" at Fountain, Pitt County; granite is quarried in this town, while both to the east and west it is about 400 feet beneath the surface.

It was suggested by the writer (Richards, 1945b) that another such hill existed near Havelock, Craven County. The well of the Great Lakes Drilling Company reached basement at 2318 feet while the more recent wells of the Carolina Petroleum Company near Merrimon, Carteret County, did not reach basement until a depth of about 4000 feet. However, the data from the additional wells drilled by the Carolina Petroleum Company (especially North Carolina Pulpwood, Atlas Plywood, and Lindley) suggest a greatly increased slope from Havelock (Great Lakes well) toward the east.

SOUTH CAROLINA

Only a few samples are available from this state. Data on some of these were provided by George Siple of the U. S. Geological Survey in Columbia, S. C., and the samples were furnished by several drillers. A recent report on ground water of South Carolina contains considerable information on the subsurface geology (Siple, 1946).

16. *Manning, Clarendon Co., S. C.* Elev. 120 ft. Depth 500 ft. ANSP.

0-500 UP. CRET. Black Creek

The tooth of a crocodile and fragments of a turtle, as well as some petrified wood, were found at a depth of 500 feet.

17. *Huspah Church, Beaufort Co., S. C.* Elev. 22 ft. Depth 142 ft. ANSP; USGS-R.

0- 40	s. cl.	PLEIST.	
40-114	s. cl. sh. frag.	MIOCENE	
114-142	ls.	EOCENE	(Santee = Ocala)

18. *St. George, Dorchester Co., S. C.* Elev. 100 ft. Depth 559 ft. ANSP; USGS-R.

0- 35	clayey s.	PLEIST.	
35- 75	sandy cl.	MIOCENE	Hawthorne
75-355	limey cl.	EOCENE	(Santee-Cooper = Ocala)
355-404		(no samples)	
404-406	s. some glauc.	UP. CRET.	Peedee
406-559	s. cl. sh.	UP. CRET.	Black Creek

Comments

1. The Eocene-Cretaceous contact probably occurs in the interval of no samples between 355 and 404 feet. Probably the Peedee (?) extends higher than 404 feet.

2. A hard limestone layer occurs in the Eocene between 275 and 290 feet.
3. Numerous fossils occur between 557 and 559 feet.

19. *Lake City, Florence Co., S. C.* Elev. 73 ft. Depth 618 ft. ANSP; USGS-R.

0- 35	sandy cl.	PLEIST.	
35- 48	s. sh. frag.	MIOCENE	Duplin (?)
48-282	sandy cl.; sh.	UP. CRET.	Black Creek
282-618	s.-no fossils	UP. CRET.	Black Creek (?)

Anomia argentaria is present in the Black Creek.

9. *Florence, Florence Co., S. C.* Elev. 142 ft. Depth 1750 ft.

0- 61	sandy cl. and gr.	PLEIST.	Sunderland
61- 205	black shaly cl. s.	UP. CRET.	Black Creek
205- 603	light micaceous s. cl.	UP. CRET.	Tuscaloosa
603-1335	ss.	TRIASSIC ?	Newark ?
1335-....	black rock; dike ?	TRIASSIC ?	Newark ?

This is an old well, drilled prior to 1896, and no samples are available. Above correlation from Richards (1945, p. 919) based on reports by Cooke (1936, p. 178) and Darton (1896, p. 218).

Florence Triassic Basin

The presence of deeply buried Triassic rocks was indicated in the well at Florence, S. C., and, questionably, in the well at Summerville, S. C. Since this had not been confirmed by recent drilling, this basin was not shown on the contour map (Richards, 1945, p. 952). However, geophysical evidence definitely supports the existence of a buried basin in this region. McCarthy (1934, 1936), on geophysical evidence, postulated a submerged Triassic basin near Sumter, S. C., past Florence, S. C. to Laurinburg. N. C.

Geophysical anomalies have been reported near Conway, S. C., a fact which may have encouraged the several oil tests in that vicinity.

GEORGIA

Samples were examined at the Department of Mines, Mining and Geology of the State of Georgia at Atlanta, through the cooperation of Captain Garland Peyton, director. Stephen Herrick of the United States Geological Survey also furnished information on certain of these wells. In addition, information has been supplied by several of the oil companies that have drilled in Georgia during the past few years. These include the Sun Oil Company, the California Company, Stanolind Oil and Gas Company, and the Kerr McGee Oil Industries.

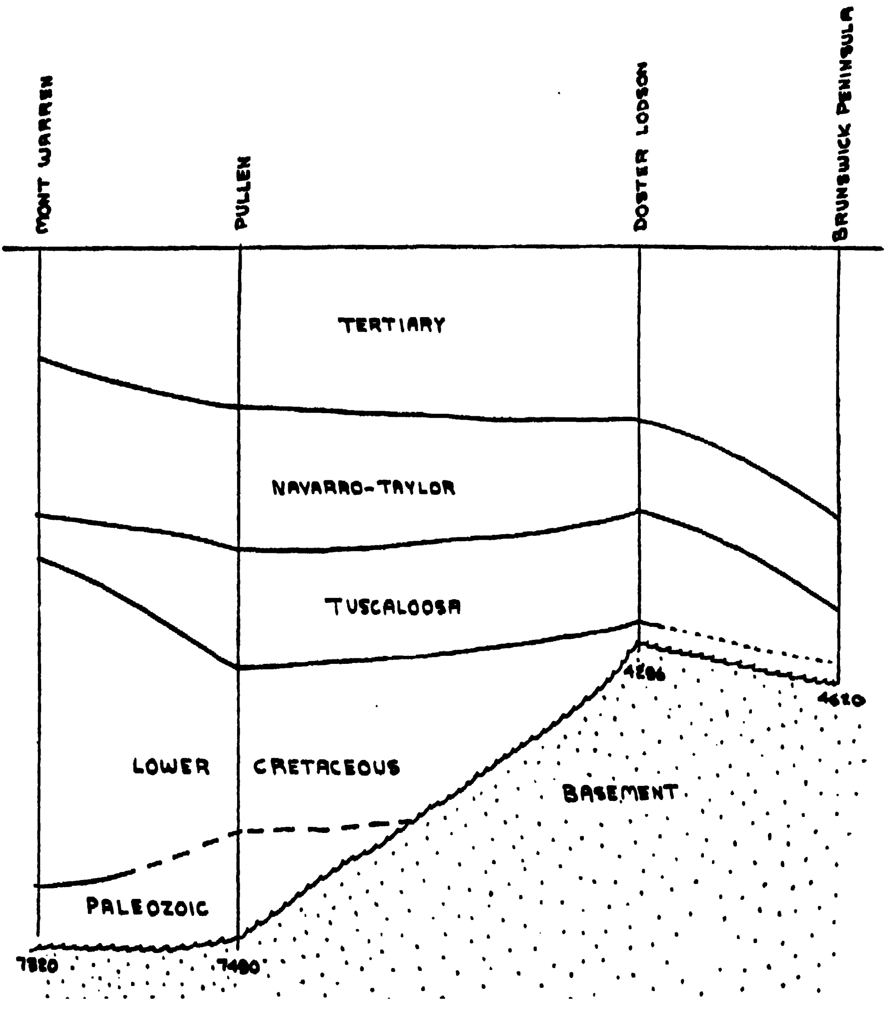

Figure 3.—Generalized section west to east across Georgia from Mont Warren Well to Brunswick Peninsula Well. (Vertical scale 1 inch = 2400 feet; horizontal scale 1 inch = 32 miles.)

The writer realizes that many details of the subsurface geology of Georgia have not been fully worked out and that there is frequently difference of opinion in regard to the correlations in this region. Therefore, the correlations given below must be regarded as tentative and may have to be altered when further information comes to light as a result of additional drilling.

28. *6.8 miles east of McKinnon, Wayne Co., Ga.* Elev. 73 ft. Depth 4620 ft. GaGS. (California Company's Brunswick Peninsula No. 1)

0- 555	MIOCENE	Hawthorne and younger
555- 682	MIOCENE	Tampa
682- 740	OLIGOCENE	Suwannee
740-1045	EOCENE	Ocala
1045-1980	EOCENE	Claiborne
1980-2627	EOCENE	Wilcox
2627-2865	EOCENE	Midway
2865-3625	UP. CRET.	Navarro
3625-3890	UP. CRET.	Taylor-Austin
3890-4065	UP. CRET.	Eagle Ford equivalent
4065-4430	UP. CRET.	Tuscaloosa
4430-4575	LOWER CRET.	?
4575-4620	BASEMENT COMPLEX	

1. Above correlation partly based on data from the California Company.

2. The marine Tuscaloosa occurs between 4310 and 4410 feet.

3. Red sands and shales between 4430 and 4575 feet are tentatively assigned to the Lower Cretaceous.

4. Basement rock is described as " altered and weathered quartzite."

29. *6.6 mi. southwest of Pearson, Atkinson Co., Ga.* Elev. 222 ft. Depth 4296 ft. GaGS; ANSP. (Sun Oil Company's Doster-Lodson No. 1)

0- 250	MIOCENE	Hawthorne and younger
250- 400	OLIGOCENE	Suwannee
400- 600	EOCENE	Ocala
600-1460	EOCENE	Claiborne
1460-1700 ±	EOCENE	Wilcox
± 1700-1840	EOCENE	Midway
1840-2440	UP. CRET.	Navarro
2440-2800	UP. CRET.	Taylor
2800-3135	UP. CRET.	Austin
3135-3940	UP. CRET.	Tuscaloosa
3940-4282	LOWER CRET.	
4282-4296	BASEMENT COMPLEX	(Schist)

Largely based on information supplied by the Sun Oil Company and the Department of Mines, Mining and Geology of Georgia. The lower part of the section is partly from Applin and Applin (1947).

According to Applin and Applin the section between 3135 and 3940 feet constitutes the type locality of the new Atkinson formation, equivalent to the lower Eutaw and the Tuscaloosa.

A few macrofossils have been identified by Dr. L. W. Stephenson, from the cores of this well and are cited by Applin and Applin.

30. *10 mi. southeast of Camilla, Mitchell Co., Ga.* Elev. 338 ft. Depth 7490 ft. GaGS. (Stanolind Oil and Gas Company's Pullen No. 1)

0- 340	MIOCENE and younger	
340- 500	OLIGOCENE	Flint River
500- 520	OLIGOCENE	Marianna
520- 710	EOCENE	Ocala
710-1150	EOCENE	Claiborne
1150-1320	EOCENE	Wilcox
1320-1560	EOCENE	Salt Mountain
1560-1710	EOCENE	Midway
1710-2905	UP. CRET.	Navarro-Taylor-Austin
2905-3660	UP. CRET.	Eutaw-Tuscaloosa (marine 3945-4300)
3660-6230	LOWER CRET.	(non-marine)
6230-7300	TRIASSIC or PALEOZOIC	
7300-7490	BASEMENT COMPLEX	

1. Largely from data supplied from the Stanolind Oil and Gas Company, Tulsa, Oklahoma.

2. The sandstone and shale between 6230 and 7300 feet have been called Triassic or Paleozoic. There are no fossils. A diabase sill was reported between 6550 and 6612 feet and at 7070 feet.

3. The following excerpts from a petrological report on certain of the core samples by Duane Reno are quoted by permission of the Stanolind Oil and Gas Company:

> "6550-6612 feet—Olivine Diabase sill, a few fragments of hornfels found in the samples near the top of the igneous rock indicated the rock is a sill and not a flow."
>
> "7375-7377½ feet—The rock is of the gabro class and the myrmekite is sufficiently unusual to be a descriptive modifier."
>
> "7486-7487 feet—Rock is metamorphosed argillaceous sandstone. The general name for this type of rock is "granulite", but the term is also used for several types of igneous rocks. Therefore to avoid confusion, the rock is called a gneiss because of its banded character."

31. *3 mi. southwest of Cedar Springs, Early Co., Ga.* Elev. 187 ft. Depth 7320 ft. GaGS. (Mont Warren et al. Chandler No. 1)

0- 615	(no samples)	
615- 950	EOCENE	Wilcox
950-1160	EOCENE	Midway
1160-1270	UP. CRET.	Navarro
1270-2400?	UP. CRET.	Taylor-Austin
?2400-2800	UP. CRET.	Eutaw
2800-3100	UP. CRET.	Tuscaloosa (including Eagle Ford equivalent)
3100-6975	LOWER CRET.	(no marine fossils)
6975-7240	PALEOZOIC	(black shale)
7240-7320	PALEOZOIC	(hard sandstone)

1. Based on data received from several sources including the Department of Mines, Mining and Geology of Georgia, Stephen Herrick of the U.S. Geological Survey in Atlanta, and the report by Applin and Applin (1947).

2. According to Applin and Applin the section between 2395 and 3298 feet constitutes the new Atkinson formation.

3. Paleozoic ostracods have been noted in the black shale between 6975 and 7240 feet by Swartz (1945). Some mollusks have also been observed (K. V. Palmer, personal communication).

4. This shale may be the same as found in the well at Hilliard, Nassau County, Florida, where ostracods have been reported. (See Campbell, 1939, Richards, 1945, pp. 928-9).

5. The hard sandstone between 7240 and 7320 feet may be the same Late Cambrian or Lower Ordovician sandstone reported from the well in Dixie County, Florida, which contained a species of brachiopod.

32. *1.5 mi. west of Arabi, Crisp Co., Ga.* Elev. 364 ft. Depth 5003 ft. GaGS. (Kerr McGee Pate No. 1)

This oil test was drilled in 1946. The samples examined were very poor. The following information was supplied by the Kerr McGee Oil Industries:

813 ft.	Top Cretaceous ?
1600 ft.	Top Austin
2070 ft.	Top Eagle Ford
2353 ft.	Top Tuscaloosa
2975 ft.	Top marine Tuscaloosa
3083 ft.	Top lower Tuscaloosa
3193 ft.	Top Lower Crateceous (?)

33. *Sea Island, Glynn Co., Ga.* Elev. 10 ft. Depth 636 ft. GaGS. (Water well)

0-120	s.	PLEIST.	
120-350	cl. some s.	MIOCENE	(middle and upper)
350-455	sandy ls.	MIOCENE	Tampa
455-636	ls.	EOCENE	Ocala

34. *Vienna, Dooly Co., Ga.* Elev. 397 ft. Depth 803 ft. GaGS; ANSP. (Layne-Atlantic water well)

0- 20	s. cl.	OLIGOCENE	
20-120	ls.	EOCENE	Ocala
120-354	sandy ls. sh.	EOCENE	Claiborne
354-650	sandy cl. some ls.	EOCENE	Wilcox
650-803	s. some cl.	EOCENE	Midway

35. *5 mi. southwest of Vidalia, Toombs Co., Ga.* Elev. 198 ft. Depth 2297 ft. GaGS. (Tropic Oil and Gas Co.)

The following notes were supplied by the Georgia Department of Mines, Mining and Geology:

0- 345	(no samples)	
345- 449	MIOCENE	Hawthorne
449- 512	OLIGOCENE	Flint River
512- 760	EOCENE	Ocala
760-1338	EOCENE	Claiborne
1338-1545	EOCENE	Wilcox
1545-1706	(no samples)	
1706-1916	UP. CRET.	unfossiliferous
1916-2217	UP. CRET.	fossiliferous
2217-2297	UP. CRET.	Cusetta-Blufftown

Atkinson Formation

Applin and Applin (1947) have recently proposed the new Atkinson formation for all pre-Austin Upper Cretaceous beds in the subsurface of Alabama, Georgia and north Florida. This formation is equivalent to the Tuscaloosa formation of the outcrop plus the lower part of the Eutaw formation, recently described as the McShand formation by Monroe, Conant and Eargle (1946). The type locality of the Atkinson formation is the Sun Oil Company's Doster-Lodson well in Atkinson County, Georgia. Three subdivisions of the formation are recognized by Applin and Applin; these are not named, and are merely designated as upper, middle and lower.

The writer thinks it unfortunate that the name Tuscaloosa should be dropped from the literature. Monroe, Conant and Eargle retained the term as a group name which they subdivided into four formations in Alabama.

Inasmuch as the present paper discusses the subsurface formations of the Atlantic Coastal Plain between Long Island and Georgia, the writer will continue to use the older terms, Tuscaloosa and Eutaw, because these are more generally in use in this region. Undoubtedly a more detailed study of the lithology and microfauna of the South Atlantic Coastal Plain will show many refinements in terminology and correlation with the better known section of the Gulf Coastal Plain. However, this is not the purpose of the present paper.

FLORIDA

While Florida is out of the scope of the present investigation, it has been thought advisable to include records from three wells from this state because of the significance of certain fossils which were submitted to the writer for identification and study.

3. *Northeast Corner of Dixie Co., Fla.* Elev. 33 ft. Depth 3671 ft. (Sun Oil Company's Langston No. 1)

This well was drilled during 1946 in the center of NW/4 SW/4 Section 8 8S 14E. An examination of the bottom core of this well (3668-3671 feet) revealed a laminated micaceous sandstone containing one specimen of the brachiopod *Lingulepis* sp.[2] (Plate 8, fig. 1). Species of this genus similar

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[2] To be described by B. F. Howell and H. G. Richards.

to the one figured are characteristic of the uppermost Cambrian and lowermost Ordovician, and its occurrence under western Florida is highly interesting. Undated sediments of Paleozoic age have been reported from several wells in Florida and Georgia, but this is the first definite record of rocks of Lower Paleozoic age from beneath the Atlantic Coastal Plain. The following is based on information supplied by the Sun Oil Company in Philadelphia:

Top of Upper Cretaceous	1772 feet
Top of Lower Cretaceous	3421 feet
Top of Paleozoic	3637 feet
Black sandy shales	3637-3668 feet
Micaceous sandstone with *Lingulepis*	3668-3671 feet

In the Stanolind-Sun's Perpetual Forest Inc. No. 1 well (center of NW/4 NW/4 Section 5 11S 11E) in Dixie County, Florida, approximately 30 miles south of the Sun Langston well, slightly over 2250 feet of Paleozoic section were penetrated.[8]

4. *Cedar Keys, Levy Co., Fla.* Elev. 15 ft. Depth 5850 ft. FlaGS. (Coastal Petroleum Company's Ragland No. 1; 3 miles north of Cedar Keys.)

This well was drilled between August 15 and October 18, 1947. Some samples from Core 15 (5840-50 feet) were received for study from Mr. Joseph Banks, geologist of the Coastal Petroleum Company. The samples consisted of a black shale containing a few poorly preserved fossils. These fossils are not identifiable, but include fragments of brachiopods, pelecypods, scaphopods and ostracods (?). The following are figured on Plate 1. (Fig. 6. Pelecypod; pectinoid. Figs. 2-4. Brachiopods; fragments. Fig. 5. Scaphopod, possibly a *Hyolithes*.)

These specimens were shown to Dr. Norman Newell of the American Museum of Natural History and Dr. G. Arthur Cooper of the U.S. National Museum who examined them but found them unidentifiable. In a personal communication, Dr. Cooper writes: "in my opinion they could not come from Ordovician or lower rocks, nor could they come from Mississippian rocks. That leaves them somewhere in the Silurian or Devonian but from the samples submitted I cannot be certain where they should be placed." The small pectinoid clam superficially resembles some described from the Devonian and Mississippian, but cannot be definitely identified.

Apparently the black shales are of Middle Paleozoic age, definitely younger than the micaceous sandstone in the Sun Langston well which contained the Cambrian or Ordovician *Lingulepis*.

According to Mr. Banks, "the Paleozoic black shale occurs at this locality below 1500 feet of lower Cretaceous red shales and sands."

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[8] Data from Sun Oil Company.

5. *Waverly, Polk Co., Fla.* Elev. 129 ft. Depth 545 ft. FlaGS. (¼ mile north of post office)

A few fossil worm tubes from this well (W-345 of Florida Geological Survey) were submitted to the writer by Dr. Robert O. Vernon, Associate State Geologist of Florida. They came from between the depths of 150 and 160 feet in a layer referred to the upper part of the Ocala formation.

Spirulaea vernoni new species Plate 9, figs. 1, 2, 5, 6, 10, 13, 17, 18.

Tube small, discoidal, coiled in approximately a single plane. Aperture circular; outer diameter of shell restricted near the aperture as usual in this genus. Outer shell marked by closely spaced concentric lines of growth which become coarser in the later formed portions of the old tubes. Tubes not as rough as in *S. mcglammerae* (Gardner). The periphery is flat in young stages, but becomes bluntly keeled in the adult portions of the tube.

Maximum diameter of holotype (A.N.S.P. 18811) 13 mm.; paratype (Fla. Geol. Surv. I 5353) 10 mm. Individuals vary in diameter from 4 to 13 mm.

Resembles *S. mcglammerae* (Gardner), but is larger and less ornamented, and is characterized by the partly flattened and partly keeled periphery.

Eleven specimens have been found representing various growth stages.

This is the first record of the genus from the Upper Eocene (Jackson), it having previously been reported from the Midway, Wilcox and Claiborne. *S. vernoni* is probably a descendant of the smaller *S. mcglammerae* which is of Midway age.

Named in honor of Dr. Robert O. Vernon, Associate State Geologist of Florida, who submitted the specimens for study.

The following correlation is abbreviated from an unpublished report on the well by Dr. Robert O. Vernon, and is quoted with his permission.

0- 50	PLEIST.	
50- 60	LOWER MIOCENE	Hawthorn
60-140	LOWER MIOCENE	Tampa ? or Lower Hawthorn
140-290	UPPER EOCENE	Ocala (typical lower)
290-340	UPPER EOCENE	Lower Jackson
340-545	MIDDLE EOCENE	Avon Park

SUMMARY AND DISCUSSION

Long Island

1. The Cretaceous deposits of Long Island are largely non-fossiliferous, and although they are usually referred to the Magothy and Raritan formations, they may include some younger material, probably equivalents of the Monmouth and Matawan groups of New Jersey.

New Jersey

2. The Jackson Eocene has been recognized in New Jersey beneath the Miocene in wells at Atlantic City, Wildwood and Cape May. It had previously been recognized from the state only from the well at Brandywine Lighthouse in Delaware Bay.

3. The Hornerstown formation (Eocene) is probably equivalent to both Midway (Paleocene) and Wilcox of the Gulf Coast, the Midway elements being best developed in the subsurface.

4. The feather edge of the Triassic (Newark series) lies on the basement complex (Wissahickon) in the well at Runyon, N. J.

5. The basement rock is very irregular in the vicinity of Penns Grove. Granite has been encountered at various depths between 278 and 408 feet in this area.

Maryland

6. The Raritan formation (Upper Cretaceous) is at least partly of marine origin as shown by the fossils in the wells at Salisbury, Berlin and Ocean City.

7. The Monmouth and Matawan groups become thinner south of New Jersey and are entirely absent in the well at Norfolk, Virginia.

8. The Potomac group (Lower Cretaceous) dips toward the coast and becomes thicker. This is especially noticeable in a " channel " which extends from Washington, D. C. through Meadows to Salisbury, Berlin to Ocean City, Maryland. The name " Salisbury Embayment " is proposed for this low area. This may indicate an ancient estuary, possibly an ancestor of Chesapeake Bay or the Potomac River; on the other hand, the basin may have been caused by faulting.

9. The Lower Cretaceous in the Berlin well is largely non-marine; however, fragments of microfossils have been found in a few cores.

10. A definite marine element of the Lower Cretaceous has been found in the well at Ocean City, Maryland.

11. The Lower Cretaceous is underlain by the Triassic (Newark series) in the Hammond well near Salisbury, and the Bethards well near Berlin. It apparently thickens toward the east. In the Salisbury well it is 169 feet thick (5360 to 5529 feet) and at Berlin it is 671 feet thick (6486 to 7157 feet). These Triassic sandstones and shales lie in the " Salisbury Basin."

Virginia

12. The Eocene is thicker on the north side of the James River than on the south side. However, this thickening may not be as great as previously

suggested. Cederstrom has postulated a fault in the basement rock to explain this variation. On the other hand, it may possibly be explained as an ancient James River embayment, similar to the Salisbury Embayment.

13. The Upper Cretaceous is represented in Virginia only by a relatively thin zone of Raritan age. It is marine near the coast, as demonstrated by the fossils, but becomes non-marine up dip. Mottled clays which underlie the Eocene inland from the coast may be of Upper Cretaceous age and equivalent to the fossiliferous Raritan of the Norfolk, Drivers and Franklin wells.

North Carolina

14. At Fountain, Pitt County, there is a granite outcrop, whereas both east and west of the town the granite is some 400 feet deep. This represents a " hill " in the basement.

15. A similar " hill " in the basement may occur in the Havelock-Morehead City area. The Havelock well (Great Lakes Drilling Company) encountered basement at 2263 feet, while the Morehead City well (Karsten) did not reach basement until a depth of 4063 feet.

16. On the other hand, the Havelock well may have been drilled at the junction of two erosional surfaces. The more gently sloping plane from the Fall Line to Havelock dips at an average rate of 14 feet per mile, while the steeper plane from Havelock to Hatteras dips at about 122 feet per mile. The theory of the two peneplanes has been expressed by Prouty and Berry in two recent brief papers.

17. Several wells near Merrimon encountered basement at about 4000 feet. Other wells between Merrimon and Havelock encountered basement at depths intermediate between 4000 and 2263 feet, thereby favoring the theory of the steeply sloping peneplane.

18. A study of the samples from the deep well at Cape Hatteras shows a thickening of most formations. Also several formations have been recognised in the well that do not crop out in North Carolina. These include, (a) Calvert formation of Miocene age, (b) the Eutaw or Magothy formation, probably a marine equivalent of the older non-marine part of the Black Creek formation of the outcrop, (c) a marine phase of the Lower Cretaceous, and (d) possibly deposits of Oligocene age.

19. The deposits of Lower Cretaceous age have been tentatively separated into their Gulf Coast equivalents by Swain, on the basis of ostracods.

20. Basement (granite) in the Hatteras well was encountered at a depth of 9878 feet.

21. The Tuscaloosa formation as recognized on the surface in North Carolina may be of both Upper and Lower Cretaceous age. It is nonmarine in the outcrop, but becomes marine down dip. In wells at Hatteras, Merrimon, etc., faunas of both Upper and Lower Cretaceous age have been recognized. It is difficult to separate the Upper Cretaceous from the Lower Cretaceous in these wells; probably deposition was continuous.

22. A study of the samples from the well in Pamlico Sound shows that the same formations are present that were in the well at Cape Hatteras. The various formations were encountered somewhat higher than at Hatteras; in other words, the Pamlico Sound well is up dip from Cape Hatteras.

23. Oligocene microfossils have been recognized in a well at Camp Lejeune, Onslow County (McLean) and possibly at Cape Hatteras.

South Carolina

24. There are indications of a buried Triassic basin near Florence. McCarthy, on geophysical evidence, has postulated a submerged Triassic basin near Sumter, South Carolina extending past Florence to Laurinburg, North Carolina. Geophysical anomalies have been reported near Conway; this evidence may have encouraged the oil tests in that region.

Georgia and Florida

25. There is evidence of a slight " high " in the basement in southeastern Georgia, the basement dipping to both the east and west.

26. Paleozoic sediments apparently underlie southern Georgia and northern Florida. Paleozoic sediments have been struck in wells in Early and Mitchell counties, Georgia, and Nassau, Madison and Dixie counties (and others) in Florida. These Paleozoic rocks, some of which contain fossils, are not all of the same age.

27. A micaceous sandstone was obtained from the bottom of the Sun Oil Company's Langston well in Dixie County, Florida (3668-71 feet), which contained a new species of the brachiopod *Lingulepis* indicating a Late Cambrian or early Ordovician age.

28. A black shale from the Coastal Petroleum Company's well near Cedar Keys, Florida, contained poorly preserved fragments of brachiopods, pelecypods and pteropods. This shale is tentatively correlated with the Middle Paleozoic (probably Silurian or Devonian).

29. Ostracods from the well at Hilliard, Nassau County, Florida, have been questionably referred to the Mississippian; fossils from the Mont Warren well in Early County, Georgia, have been merely determined as Paleozoic.

30. A new species of the annelid *Spirulaea* is described from the Ocala (late Eocene) from a well at Waverly, Polk County, Fla. This is the first time that this genus has been reported from the late Eocene (Jackson) of North America. It was previously known from the Midway, Claiborne and Wilcox.

31. The Atkinson formation recently described by Applin and Applin for South Georgia, Florida and Alabama, is equivalent to the Tuscaloosa formation and part of the Eutaw as previously used in Georgia and Alabama. Since the present paper attempts to show a correlation along the Atlantic Coastal Plain from Georgia north to New Jersey, it seems more desirable to use terms generally in use along the East Coast, such as Tuscaloosa and Eutaw, rather than to use the new name, the Atkinson, which formation is best developed in the subsurface of Georgia and Florida.

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* For convenience, it is assumed that these reports appeared during the year for which they were written. Thus, Woolman (1890) means the report for 1890.

EXPLANATION OF PLATES

PLATE 8

Fig. 1.—*Lingulepis* sp. Sun Langston well, Dixie Co., Fla., 3668-71 feet (× 1).
Figs. 2-4.—Fragments of brachiopods (?). Cedar Keys Fla., 5850-5860 feet (× 10).
Fig. 5.—Hyolithes ? Cedar Keys, Fla., 5850-60 feet (× 5).
Fig. 6.—Pectinoid pelecypod. Cedar Keys, Fla., 5850-60 feet (× 10).

PLATE 9

Figs. 1, 2.—*Spirulaea vernoni* new species (type), Waverly, Fla., 150-60 feet (× 5).
Fig. 3.—*Hamulus protoonyx Richards.* Pamlico Sound, N.C., 4720-30 feet (× 5).
Fig. 4.—*H. onyx* Morton. Pamlico Sound, N.C., 2810-20 feet (× 5).
Figs. 5, 6, 10, 13.—*Spirulaea vernoni* new species (paratypes). Waverly, Fla., 150-60 feet (× 5).
Fig. 7.—*Exogyra woolmani* Richards. Pamlico Sound, N.C., 4090-4100 feet.
Fig. 8.—*Hamulus protoonyx* Richards. Pamlico Sound, N.C., 4720-30 feet (× 5).
Fig. 9.—*H. onyx* Richards. Ocean City, Md., 2430-40 feet (× 5).
Fig. 11.—*Turritella* sp. Ocean City, Md., 7650-60 (× 5).
Fig. 12.—*Ostrea* sp. Pamlico Sound. N.C., 5030-40 feet (× 5).
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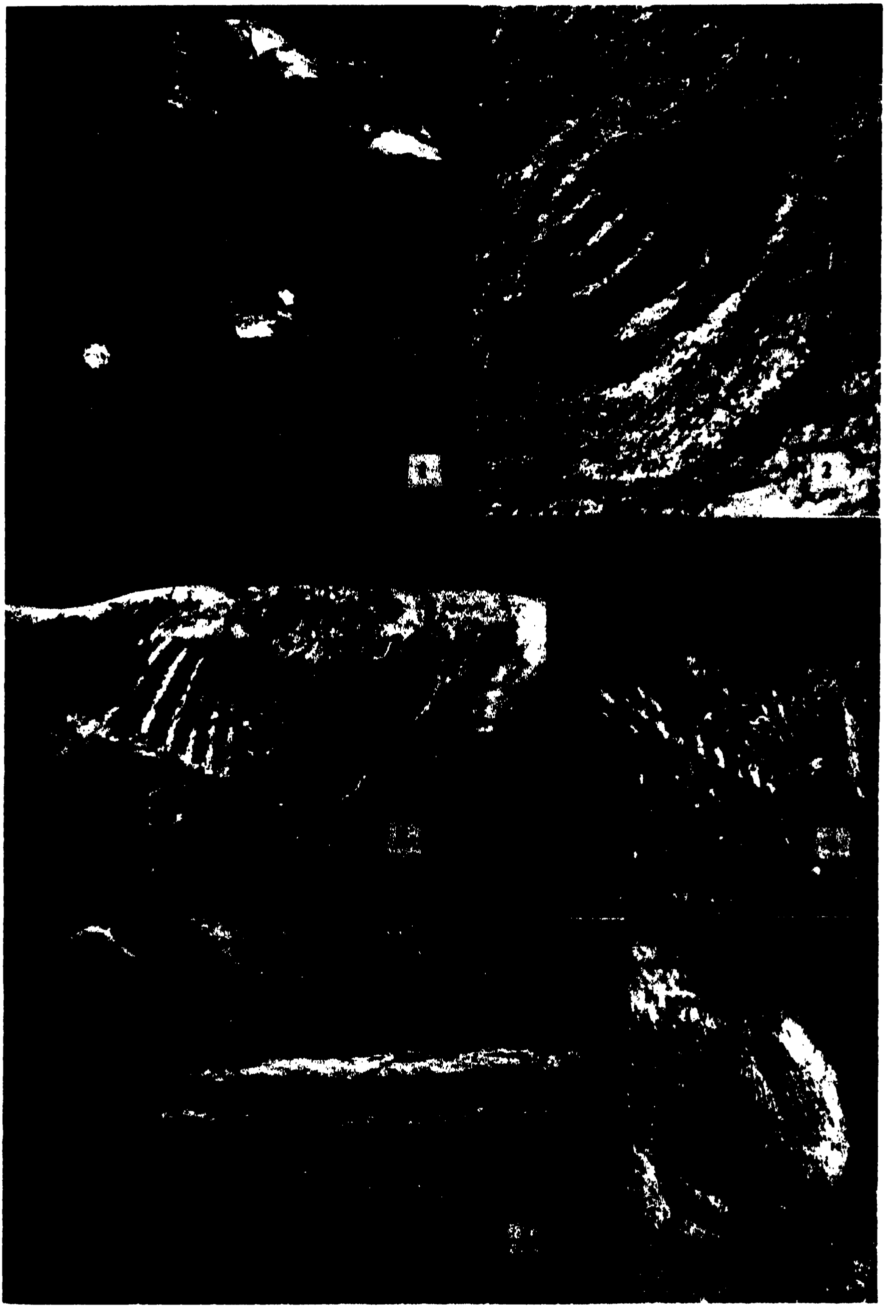
Fig. 16.—*Filograna socialis* (Goldfuss) Pamlico Sound, N.C., 2810-20 feet (× 3).
Figs. 17, 18.—*Spirulaea vernoni* new species. Waverly, Fla., 150-60 feet (× 3) (17 = type).



RICHARDS: SUBSURFACE GEOLOGY

RICHARDS: SUBSURFACE GEOLOGY

THE ACRIDOID FAMILY EUMASTACIDAE (ORTHOPTERA). A REVIEW OF OUR KNOWLEDGE OF ITS COMPONENTS, FEATURES AND SYSTEMATICS, WITH A SUGGESTED NEW CLASSIFICATION OF ITS MAJOR GROUPS

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Nearly forty years ago, on the slopes of the San Gabriel and San Jacinto Mountains of southern California, I first became acquainted with living individuals of the interesting locusts of the Eumastacidae. On numerous occasions since, in the southwestern United States, I have renewed this contact with the sprightly and elusive members of the endemic genera *Morsea* and *Psychomastax*, and in the last few decades I have also been privileged to broaden this field acquaintance with the family elsewhere, in Honduras, Costa Rica, Colombia, interior Brazil, and East and Central Africa.

The particular fascination these oddly formed and strangely specialized locusts have always held for me, is probably due to the fact that they violate numerous general ideas about locusts as a whole, and within their relatively limited aggregation display a wide range of structural diversification, of adaptation to an exceptional variety of habitats, with at times added remarkable protective resemblance, and finally often possess an extraordinary development of saltatorial powers. Whether one encounters them in extremely arid deserts, in the undergrowth of lowland humid tropical forests, or as ground dwellers in mist-saturated subtropical cloud forest, they remain the same interesting and intriguing sprites. In many of them the usual pose is one of tense and constant alertness, often accentuated by the short, upraised and apparently very sensitive antennae, and the cross bow-like action of their caudal limbs is capable of projecting them an unbelievable distance when they feel danger threatens. I have found that the eumastacids are also objects of special interest to my immediate colleagues who are interested in the Orthoptera, and their acquaintance with them in lands where I have not worked, as Mexico, South Africa, New Guinea, the Philippines, Assam and Burma, similarly has left vivid memories.

In the years since my first field acquaintance with the eumastacids, jointly with co-workers I have published certain systematic studies dealing with members of this family,[1] all of these papers having had regional backgrounds. Certain broad and general conclusions have in consequence been slowly crystallizing over the years, largely along lines which have not been discussed in the several systematic revisions of the family published by other authors. For a number of reasons it seems desirable at this time to present, review and digest some of these observations, with the addition of a brief summary of past contributions on the classification of the Eumastacidae, of such correlated evidence as has been published or is now available on anatomical and cytological characteristics of the family, an appraisal of the constancy or plasticity within the same of a number of external morphological characters, and a suggested rearrangement of the major groups into which, on the basis of my observations and comparisons, the family can be divided, and finally to give some suggestions as to its phylogenetic development.

One very compelling reason for the presentation at this time of this analysis of the characters and groups of the Eumastacidae is, that in connection with a comprehensive study of the Acridoidea of Australia, with which I am at present engaged, I have been under the necessity of reviewing or studying anew the basic classification of the family. Errors in the past family assignment of certain genera from that part of the world were made apparent, and the rectification of these in turn made necessary a full recasting of the characters and limits, as well as the components, of one of the divisions of the Eumastacidae found in Australia, as well as its integration in the general phylogenetic pattern of the family.

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The present analysis was in part inspired by critical and valuable observations made on certain of the Australian genera involved by Dr. K. H. L. Key, Senior Research Officer of the Australian Council for Scientific and Industrial Research, an orthopterist whose studies have been characterized by a thoroughness and a scholarly presentation of evidence and conclusions all too rare in contemporary work. From the leads given by Dr. Key, as the analyses amplified, I found that a number of features of marked value in grouping the seventy-odd known genera of the family had been completely or very largely overlooked or ignored, and that certain of the most divergent elements of the family had either never been associated with it, or where once properly placed, this disposition had been disregarded or virtually ignored in subsequent studies. To the kind and ever generous cooperation of Dr. Key, who unreservedly placed his observations before me, I am very deeply indebted. My thanks are also due my colleague Dr. H. Radclyffe Roberts, who similarly placed at my disposal most important and valuable personally collected material of the subfamily Tanaocerotinae, and all his field notes on the same, without which the conclusions here presented would be much less comprehensive. I am also under obligation to my friend Dr. Ashley B. Gurney, Custodian of Orthoptera at the United States National Museum, and to Dr. E. A. Chapin, Curator of Insects at the same institution, for the loan of material of the genus *Pielomastax*, which is unrepresented in the Academy collection, although the latter possesses determined material of forty-four of the known genera of the family.

The present study in no way anticipates the forthcoming work on the Australian members of the family, other than by correct alignment of one of the major groups which is peculiar to Australia, and an analysis of its systematic features.

While the Eumastacidae have variously been considered a family or a subfamily, it is now generally believed, with the supporting evidence of internal features of distinctive character, that the group should rank equally with the Pneumoridae, Tetrigidae, Proscopiidae and Acrididae as one of the major divisions, of family rank, of the superfamily Acridoidea.

Historical Classification Résumé

The first effort made to define, and then divide into major components, the group now called the Eumastacidae was that of Stål in 1876.[2] He created for it two family divisions, which he called the Mastacidae and the

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[2] Öfversigt K. Vetensk.-Akad. Förhandl., XXX, no. 3, p. 54, footnote 1, (1876).

Choroetypidae, the former to contain the genera *Mastax* of Perty (=*Eumastax* of Burr and present-day authors) and his *Erucius* and *Thericles*, while the Choroetypidae embraced *Chorotypus* of Serville (=*Choroetypus* as amended) and *Erianthus* of Stål. The two groups were broadly associated by him with the Proscopiidae (sic Proscopidae) and Pneumoridae, and more distantly with the Tetrigidae (or Tettigidae as there used), on account of their agreement in lacking auditory organs, or at least of external evidence of auditory tympana. The Mastacidae were characterized as having the ocelli close to the eyes, the latter little distant from one another, the fastigium narrow, occasionally compressed and lacking a median carina, and the tegmina, when present, very remotely reticulate. The Choroetypidae, by contrast with the Mastacidae, were defined as having the ocelli more remote from the eyes, the latter quite distant from one another, the fastigium depressed in form yet ascendant and always carinate on the cephalic aspect, while the tegmina were described as densely reticulate.

In 1889 Karsch followed the basic division made by Stål, and discussed the elements known to him which he placed in the respective categories.[3] In the Choroetypidae he placed *Choroetypus* and his new African genus *Plagiotriptus*, while the Mastacidae he split on the character of the cephalic femora into two subsidiary groups, termed the Erianthena and Mastacina. In the first of these divisions he placed three genera from southeastern Asia, Indo-Malayia and New Guinea, i.e. *Mnesicles* Stål, *Adrapetes* Karsch and *Erianthus* Stål. The second division he arranged in three geographic subdivisions: the first including the Asiatic *Erucius* Stål, which on account of the toothed lateral margins of the dorsal surface of the caudal metatarsi he considered somewhat isolated and transitional to the Erianthina; the second including the American genera *Mastax* Perty (=*Eumastax* of today) and *Masyntes* Karsch; while the third was composed of the African and Malagasy genera *Penichrotes* Karsch, *Thericles* Stål, and *Macromastax, Peoedes* and *Euschmidtia* Karsch.

In his great 1893 " Révision " Brunner[4] combined the two divisions of Stål and Karsch and termed the whole the Mastacidae, but utilized the two entities (i.e. Choroetypi and Mastaces) as its major divisions, basing them on the different character of the interantennal development of the frontal costa. He retained the generic associations set forth by Karsch, and added but a single new genus, this erected on an undescribed species.

In 1898, in a study of certain Oriental and Indo-Malayan Orthoptera, Brunner reaffirmed[5] the classification used by him in 1893, and added the new genera *Scirtotypus* and *Orchetypus* to the Choroetypi, *Eupatrides* to the Mastaces, and *Gomphomastax* without indication of its affinity.

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[3] Entom. Nachrichten, XV, pp. 7-10, 24-36, (1889).

[4] Ann. Mus. Civ. Stor. Nat. Genova, XXXIII, pp. 114-117, (1893).

[5] Abhandl. Senckenb. Naturforsch. Gesellsch., XXIV, pp. 216-233, (1898).

The first comprehensive systematic study of the Eumastacidae was that produced by Burr in 1899.[6] In it was presented the first diagnosis of the family, as well as the first analysis of its general characteristics, and also of the geographic distribution of its components. The fact that Perty's generic name *Mastax* was preoccupied by *Mastax* Fischer, used for Coleoptera and published in 1825, was pointed out and the new generic name *Eumastax* was proposed to replace it, hence the present name of the family. Burr recognized thirty genera, of which seven were described as new.[7] Of major divisions he recognized eight; the Choroetypi with six Oriental, Indo-Malayan or African genera, the Erianthi with four Oriental or Indo-Malayan, the Gomphomastaces with one from northern India and Central Asia, the Erucii with three Indian or Indo-Malayan, the Episacti with two Neotropical, the Chinae with one Oriental, the Eumastaces with four Neotropical or Nearctic, and the Thericleis with nine African or Malagasy. Burr's key for the separation of the genera is based on that given by Brunner in 1893, amplified to include the new genera proposed. While this study was considered by its author as a purely preliminary one, it constituted the most important study of these insects which had appeared up to that time.

In 1903 Henri de Saussure added a very important study to our knowledge of the Eumastacidae, entitled "Notice sur la Tribu des Eumastaciens."[8] In this work, which is largely filled with descriptions of numerous new species and four previously unrecognized genera, Saussure divided the group into six "stirps," and discussed eighteen genera and many species representative of six of these. Keys to the genera of certain of these major divisions were given, and also to the species of a number of the genera. His discussion of the Choerotypites in particular is of the analytic character so valuable and frequent in Saussure's writings.

Also in 1903 Burr presented the fascicule of the "Genera Insectorum" dealing with the Eumastacidae,[9] in it using a group arrangement which in its basic structure has been very largely followed since that time. His definition of the family was that given by him in 1899, but he increased the number of major groups, which he termed subfamilies, to eleven. These were the Choroetypinae with seven Oriental, Indo-Malayan and African genera (one new), the Erianthinae with six genera then considered widely distributed over the tropics of both hemispheres, the Gomphomastacinae with one Central Asian and north Indian genus, the Erucinae with four Oriental and Indo-Malayan genera, the Episactinae with four Neotropical and Malagasy genera, the Thaumastacinae with one Neotropical genus, the Chininae with one Oriental and one Indo-Malayan and Papuan genus, the Eumastacinae with five Neotropical and Nearctic genera, the Thericleinae with ten African and Malagasy genera, the Psednurinae with one new Australian genus, and the Miraculinae with one Malagasy genus. We now know that the genus *Thaumastax,* which formed the entire basis for the Thaumastacinae, is a synonym of the cyrtacanthacridine genus *Taeniophora* Stål, 1873,[10] hence the subfamily is invalid, and, as shown on a following page, *Psednura,* as limited by its first type designation to another cyrtacanthacridine genus, similarly cannot be used for a eumastacid subfamily, although Burr in this work was the first to point out that there existed a very distinct subfamily of the Eumastacidae peculiar to Australia.[11] The total number of genera treated in Burr's 1903 study was forty.

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[6] "Essai sur les Eumastacides." Anales Soc. Españ. Hist. Nat., XXVIII, pp. 253-304, 345-350, pls. VIII and IX. Also issued as a separately paged work (1-94).

[7] One of these is *Mastacides*, there credited to Ignacio Bolívar, but the description was prepared by Burr, and the name alone was Bolívar's contribution. This genus should be credited to Burr, as was done by Kirby (Synon. Catal. Orth., III, p. 74, (1910)).

[8] Revue Suisse de Zoologie, XI, pp. 43-112, pl. 3.

[9] Genera Insectorum, Orth., Fam. Eumastacidae, pp. 1-23, 1 plate, (1903).

In 1930, and preceded by certain preliminary papers on the same subject, there appeared from the pen of Candido Bolívar the first part of the most comprehensive study of the family which has been published.[12] The second part of this work, due largely to exigencies beyond the control of the author, has not as yet been published. The preliminary non-classificatory portion of this monograph included among other matters a summary of the sources of the extensive material studied, a characterization of the group as a whole and an analysis, element by element, of the general characters of the family, a discussion of sexual dimorphism and secondary sexual characters as there found, and summaries of our knowledge of the biology and geographical distribution, which were followed by a key to the ten subfamilies which he then recognized. One of these latter first appeared in this study, i.e. the Biroellinae, based on the single Papuan and Australian genus *Biroella,* which had been described by Ignacio Bolívar in 1903. The issued section of this work (Primera Parte) dealt only with six of the subfamilies, the author's intention being to treat the other four in the second part, as yet unpublished. The subfamilies treated were: the Chorotypinae,[13] containing four previously known genera of the Oriental, Indo-Malayan and Ethiopian regions; the Erianthinae, including thirteen genera, of which the author had not seen *Teicophrys*, the sole New World entity there assigned,[14] while of the remaining twelve of Ethiopian, Oriental, Indo-Malayan and Papuan distribution four were described as new; the Eruciinae, with two previously known Oriental, Indo-Malayan and Papuan genera; the Gomphomastacinae, including the north Indian and Central Asian genera *Gomphomastax* and *Paedomastax*, the latter there described; the Biroellinae, containing the single Papuan and Australian genus *Biroella;* and the Chininae, embracing solely the Oriental genus *China*. This monograph is the most comprehensive single work on the Eumastacidae which has been produced. One of its weakest points was the author's failure to associate sexes of certain species, which, as noted by him a few years later, were considered in the Monograph to represent genera of different subfamilies (i.e. the subgenus *Chescirtypus* of the genus *Orchetypus* in the Chorotypinae, and *Hemierianthus* in the Erianthinae). The author also allowed himself to be influenced by Sjöstedt's erroneous placement of the genera *Moraba* and *Callitala* in the Acridinae of the Acrididae, and thus failed to treat one of the most distinctive and remarkable Old World sections of the Eumastacidae, even though Burr had suggested this relationship. The excellent figures presented in the Monograph provide most valuable aids in the recognition of many of the genera and species treated, these augmented in importance by many of them having been made from types which previously were not or but unsatisfactorily figured.

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[10] See C. Bolívar, Trab. Mus. Nac. Ciencias Naturales, Madrid, Ser. Zool., núm. 46, p. x and footnote 1 on same page, (1930).

[11] Elsewhere in this study the name Morabinae is proposed for this important group.

[12] "Monografía de los Eumastácidos (Orth. Acrid.). Primera Parte." Trab. Mus. Nac. Ciencias Naturales, Madrid, Ser. Zool., núm. 46, pp. I-XXXII, 1-380, 186 figures. Issued December 25, 1930.

In one of a series of studies supplementary to his Monograph, Candido Bolívar presented a revised table of the genera which he considered to make up the Chorotypinae,[15] there also synonymizing his 1930 genus *Kirbyita* under the older *Orchetypus* Brunner, his *Ebneridia,* similarly erected in 1930, under Burr's earlier *Bennia,* and Willemse's *Celebomastax* under *Eupatrides* also of Brunner. At the same time he showed that the West African species referred by him in 1930 to his new subgenus *Chescirtypus* of the genus *Orchetypus,* represented females of species previously placed in the genus *Hemierianthus* on the basis of males alone. Further he cancelled the classic subfamily Eruciinae, removed its typical genus *Erucius* to the now broadened Chorotypinae, and expressed the belief that the genus

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[13] This spelling, based on that used by Serville when originally erecting the genus *Chorotypus,* is now generally adopted in place of that based on the emended form *Choroetypus.*

[14] This was placed in a distinct subdivision by Rehn and Rehn in 1939.

[15] Livre Cent. Soc. Entom. France, pp. 669-679, (1932).

Mastacides, placed by him in 1930 in the first mentioned subfamily, might prove to be nearer the Thericleinae. To the now polyphyletic Chorotypinae he added all ten of the valid genera placed by him in the similarly classic subfamily Erianthinae, which thus joined the Eruciinae as discarded entities.

In 1934 Rehn and Rehn inaugurated a series of regional studies of the family, distributed through which are various conclusions bearing upon the character and relationship of generic and higher entities. While first inclined to regard the entire assemblage as a subfamily and the major divisions as "groups," later, largely from the evidence presented by anatomical studies of other workers, they adopted the valuations given by Candido Bolívar, considered the whole as of family rank and regarded the major subdivisions as subfamilies. The first of these papers[16] is of primary importance in that it reviewed, discussed and redefined the American genera which had been referred to the "Episacti" (= Episactinae), and added a previously undescribed Central American one (*Lethus*).

The second of the Rehn and Rehn studies inaugurated a series of papers intended to be a comprehensive review of the New World members of the family. The first part of this review[17] treated the genera and species of the "groups" "Teicophryes," "Espagnolae," and "Episacti." The two former of these were previously unrecognized as natural groups, very little material of the first having been seen previously, and the relationship of its typical genus *Teicophrys* was completely unknown to Candido Bolívar, who had assumed it might belong to the Erianthinae. One new genus of the Teicophryes was described, and both it and *Teicophrys* were shown to be limited to south-central Mexico and the Cape Region of Baja California, while the "Espagnolae" was erected to include a very distinctive new genus (*Espagnola*) from Hispaniola. Five genera were assigned to the "Episacti," one from Hispaniola (*Antillacris*) being described as new. The second section of the Rehn and Rehn review of New World forms[18] treated certain of the genera there considered referable to the "Group Eumastaces" (= Eumastacinae as now understood). Of these genera two South American ones were described as new (*Temnomastax* and *Eumastacops*), both including new and previously known species which had been referred respectively to *Masyntes* and *Eumastax*.

In 1945 the same authors brought out the first of several projected studies on the Eumastacidae of Africa and Madagascar.[19] In this paper three new genera were added to those currently referred to the Thericleinae, one from southeastern Africa (*Amatonga*) and two from Madagascar (*Carcinomastax* and *Amalomastax*). The first of the latter exhibits a type of sexual dimorphism in the median limbs previously not noted in the Eumastacidae.

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[16] "The Eumastacinae of Southern Mexico and Central America." Mem. Amer. Entom. Soc., no. 8, pp. 1-84, pls. I-VI, 2 text maps, (1934).

[17] "A Review of the New World Eumastacinae (Orthoptera, Acrididae).—Part I." Proc. Acad. Nat. Sci. Phila., XCI, pp. 165-206, pls. 6-8, text-figs. 1-6, (1939).

[18] "A Review of the New World Eumastacinae (Orthoptera, Acrididae).—Part II." Proc. Acad. Nat. Sci. Phila., XCIV, pp. 1-88, pls. 1-2, text-figs. 1-60, (1942).

[19] "A Contribution to Our Knowledge of the Eumastacidae (Orthoptera, Acridoidea) of Africa and Madagascar. Part I." Proc. Acad. Nat. Sci. Phila., XCVII, pp. 179-248, pls. 17-21, text-figs. 1-32, (1945).

In one of the most valuable analytic studies we have on the relative value of the major groups of the Acridoidea, but of particular value in its discussion and analysis of the divisions of the true Acrididae, Roberts has tentatively reaffirmed[20] the position given the Eumastacidae by Stål and other early workers, i.e. of nearest relationship to the Proscopiidae, and a somewhat more distant one to the Tetrigidae.

General Distribution

While our knowledge of the life-histories of the members of the Eumastacidae is exceedingly limited, and of their distribution as yet quite spotty, enough is known to show that they are almost as varied in their ecological requirements as they are in their structural diversity, and that in its distribution the family places before us a picture undoubtedly reflecting the action of broad and basic controls extending well into the past. Long considered to be an essentially tropical group, and clearly reaching the greatest diversity in form in the tropics, they also occur in temperate regions of both hemispheres at relatively high altitudes,[21] and in situations where comparatively frigid conditions are the rule for a considerable part of the year. In consequence these mountain forms must have comparatively short life cycles. Certain genera of the family are inhabitants of extreme desert areas in parts of the New World and of interior Australia, and probably certain species will be found restricted to similar situations in other regions of the Old World.

No member of the family is known from Europe or the truly Palearctic northern section of Africa, or from northern Asia, while in the Nearctic Region the Eumastacidae is present in but a limited part of the southwestern United States. As far as known at present the family is unrepresented in the Antilles except in Cuba and Hispaniola, and in South America it is absent from Chile and the southern part of Argentina. No islands of the Pacific east of New Guinea have eumastacids in their faunas, nor does New Zealand. Of the smaller island groups of the Indian Ocean they are known only from the Seychelles (*Peoedes*), yet Ceylon has a diversified eumastacid fauna. The areas of greatest specific diversity of the Eumastacidae are the Indo-Malayan and Oriental regions, followed by the Ethiopian and Malagasy on one hand, and the Neotropical on the other. More genera are known from the Ethiopian and Malagasy regions than from any other single or combined areas, but the known species from these regions are less numerous than from the Oriental and Indo-Malayan ones.

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[20] Proc. Acad. Nat. Sci. Phila., XCIII, p. 232, (1941).

[21] In the Old World *Gomphomastax* has been reported from as high as 11,000-13,000 feet in Kashmir (C. Bolívar, 1930), *Phaedomastax* was taken at an unstated elevation in the alpine Karakoram area of Soviet Central Asia near the northern frontier of India (Uvarov, 1914), and *Gomphomastax* at the Irghailyk Pass in northern Afghanistan (Mistshenko, 1938), while *Brachymastax* was described from material taken between 8100 and 9100 feet in Afghanistan (Ramme, 1939). In the New World *Psychomastax* has been recorded from as high as 11,500 feet on Charleston Peak, Nevada, and 10,700 feet in both the White Mountains and the Sierra Nevada of California (Hebard, 1934). The genus *Tanaocerus*, which over most of its range in the southwestern United States is an inhabitant of relatively low and very hot desert, is known to range as high as 8200 feet in the White Mountains of California (Rehn, 1948).

Geological History

The first fossil form definitely referred to the Eumastacidae (called by him the Mastacinae) was *Promastax archaicus* of Handlirsch,[22] described from the Oligocene of British Columbia. This genus, he then stated, has " more primitive characters " than the recent members of the family. Prior to that date Scudder had erected the genus *Taphacris* [23] for the species *T. reliquata*, from the Miocene of Florissant, Colorado, and subsequently Cockerell added two species to this genus from the same deposit.[24] While Scudder considered the genus acridoid, he did not specifically assign it to any particular section, and Cockerell at first considered the earlier of his two names to be based on a member of the Mecaptera, to which he gave the generic name *Eobanksia*, but after a conference with Tillyard he decided it was acridoid and belonged to Scudder's genus *Taphacris*. The genus *Taphacris* was subsequently referred to the Eumastacidae by Zeuner in 1944.[25]

In 1939, in discussing the history and phylogeny of the acridoid stock, Zeuner considered [26] that their essentially characteristic features of " shortened antennae, reduction to three of the number of tarsal segments, and reduction of the ovipositor," did not develop before the Upper Jurassic. He then expressed the opinion that the Acridoidea " very early acquired the lateral resting-position of the elytra, folding them along the cubitus," and,

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[22] Contrib. to Canad. Paleont., II, pt. III (Mem. no. 12-P, Canad. Geol. Surv.), p. 97, (1910). The generic name is erroneously given in one place as " *Promastox*."

[23] Fossil Ins. No. Amer., II, p. 226, pl. 12, figs. 8, 19, (1890).

[24] *Eobanksia bittaciformis* Cockerell, Amer. Journ. Sci., (4) XXVII, p. 384, figs. 8 and 9a, (1909). Referred later to *Taphacris* by Cockerell, Proc. Entom. Soc. Wash., XXVIII, p. 142, (1926).
Taphacris bittaciformis var. *tillyardi* Cockerell, Proc. Entom. Soc. Wash., XXVIII, p. 142, (1926). In part: *Eobanksia bittaciformis* Cockerell, Amer. Journ. Sci., (4) XXVII, p. 384, fig. 9b, (1909).

[25] Ann. Mag. Nat. Hist., (11) XI, p. 360, (1944).

[26] Fossil Orthoptera Ensifera, text vol., pp. 56-58, (1939).

apropos of the manner of stridulating, that " the rubbing of the hind femora against the elytra and the side of the abdomen has probably been typical of the Acridioidea [=Acridoidea] since early times." He also stated that " when the auditory organ in the first abdominal segment appeared, cannot be decided on the fossil evidence." That author errs, however, on page 58 of the same work, in crediting the Acridoidea as a whole with possessing " a tympanal auditory organ in the first abdominal segment," as the absence of this has long been considered a eumastacid feature. Zeuner then regarded the Acridoidea, as now understood, as first appearing in the Lower Tertiary, and its representatives then were forms " which can by no means be called primitive." Further he expressed the belief, which he reiterated more definitely in 1942, that the superfamily evolved from the primitive acridoid Locustopsidae of the Triassic and Liassic (which was also asserted by Handlirsch in 1908), and this in turn, he considered, " is easily derived from the Caloneuridae of the Palaeozoic."

In 1942 Zeuner elaborated[27] his argument that the Locustopsidae are definitely ancestral to the modern Acridoidea, but pointed out that as to the families of the higher Acridoidea, i.e. the Pneumoridae, Eumastacidae and Acrididae, " none of these can claim to be more closely related to the Locustopsidae than any other." Relative to the Eumastacidae he then stated they " exhibit a combination of primitive and specialized features," and added that " the character which reminds me most strongly of the Locustopsidae is that the apical portion of the elytron is nearly always wider than the basal."

In 1944 Zeuner assembled,[28] preparatory to treatment in a paper as yet unpublished, six fossil species which he regarded as possibly belonging to the Eumastacidae. These forms are:

Taphacris reliquata Scudder. Miocene. Florissant, Colorado.
Taphacris bittaciformis (Cockerell). Miocene. Florissant, Colorado.
Taphacris tillyardi Cockerell. Miocene. Florissant, Colorado.
Promastax archaicus Handlirsch. Oligocene. British Columbia.
Spec. indet. Eumastacidae. Quiévreux.
Orthacanthacris rhenana Théobald. Oligocene. Baden, Germany.

The last mentioned species[29] originally was referred in error to a genus of existing bird-locusts (Acrididae, subfamily Cyrtacanthacridinae).

The evidence here summarized indicates the period of probable emergence of the Eumastacidae as a recognizable entity as Oligocene.

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[27] Proc. Royal Entom. Soc. London, Ser. B, XI, p. 2 et seq., (1942).

[28] Ann. Mag. Nat. Hist., (11) XI, pp. 360-361, (1944).

[29] Ins. Foss. Terr. Olig. France, Nancy, p. 160, pls. V, fig. 3, XIII, fig. 1, (1937).

Features Characteristic of the Family

In his 1899 " Essai " Burr gave a brief analysis of the features which he considered diagnostic of the family, certain of which, we now know, are without value in that connection. Candido Bolívar, in his 1930 " Monografía," points out that while at first sight it is very easy to recognize the members of the family, it is more difficult to put in a few lines a definition which would include all of them. Of the features brought forward as diagnostic by these two authors several require modification or elaboration.

Burr stated the body was " not inflated nor very elongate." In the genus *Brachytypus* the body is moderately inflated, and the same is true, to a degree, in the female sex of *Tanaocerus,* which latter, of course, was unknown to Burr. In the male sex of *Carcinomastax* there is also a pronounced inflation of the median femora. Further, all the members of the Morabinae known at this writing are quite definitely elongate, most of them markedly attenuate. The antennae were also said by both authors to be very short, shorter than the cephalic femora, except in the genera *Gomphomastax* and *Miraculum.* As a matter of fact numerous genera have the antennae as long as or longer than the cephalic femora; the members of the subfamilies Morabinae, Tanaocerotinae and Malagassinae, as well as of the Gomphomastacinae and Miraculinae, all or nearly all have the antennae definitely longer than the cephalic femora. The unique position previously given to the genus *Gomphomastax* for the elongate character of its antennae must be shared with the two known genera of the Tanaocerotinae (*Tanaocerus* and *Mohavacris*), which in the degree of this development much surpass *Gomphomastax.*

Among the other features considered as diagnostic by Candido Bolívar may be mentioned the unarmed prosternum, the absence of auditory tympana from the sides of the proximal abdominal tergite (which was first pointed out by Stål), the presence of tarsal arolia, the separation of the foveolae of the fastigium, and the normal form of the caudal femora, although the latter was said to be very varied.

While the prosternum is variously sculptured it is never spiniform in development as in certain subfamilies of the Acrididae, nor does it form a broad infra-gular apron as in the Tetrigidae. The absence of auditory tympana from the proximal abdominal tergite is shared with the Proscopiidae, as pointed out by Candido Bolívar, while the presence of tarsal arolia is similarly an attribute of the same two families. The structure of the whole fastigial region presents many modifications in the family, while foveolar areas usually are not well marked and sometimes completely obscured in certain genera by the development of a rostrate fastigium. The caudal femora can hardly be called " normal " in form, for in many genera they possess a special modification which permits broad lateral freedom of movement of the femora and coxae, which is discussed on a following page. In this respect also, we have a development similar to what we find in the Proscopiidae.

The following features, with their degrees of qualification, present a fairly comprehensive summary of the outstanding external characteristics of the Eumastacidae, as drawn from the present study and the past literature.

Acridids of medium to small size, with form ranging from moderately inflated to attenuately elongate, sometimes strongly compressed and sublamellate, fully alate, brevialate or apterous. Head ranging from elongate mitriform (Morabinae) to an opposite extreme with the face strongly, sharply and broadly flattened; fastigium from little developed to rostrately produced; frontal costa reaching dorsad to ventral surface of fastigium when this is rostrate or subrostrate, or continuous with fastigial disk or separated from latter by a transverse carina, dorsal section often expanding briefly into a scutellar broadening, ventrad of median ocellus of usual carinately bordered acridoid type, subobsolete to obsolete, or represented by a single carina (Teicophryinae and Tanaocerotinae). Antennae filiform, ensiform or with individual articles prismatically trigonal (Miraculinae), number of articles ranging from 8 to 27, ventral surface of a single article (distal to fifth from apex) with a distinct, though often minute, elevated node or point.[30] Pronotum sellate in most forms, in some strongly compressed and lamellately developed, and expanded, extending caudad over tegmina and forming a high cristate subfoliaceous structure. Proximal abdominal tergite without evident lateral auditory tympana.[30] Females with one or more abdominal tergites preceding the supra-anal plate with a marked mediolongitudinal fold or fissure. Pleuro-sternal suture well defined on both mesothorax and metathorax (obsolete to subobsolete in the Acrididae).[30] Mesosternum and metasternum strongly united into a more obviously single structure than in the Acrididae, in the majority of genera with the lateral and cephalic borders markedly cingulate.[30] Caudal femora with or without a dorso-proximal overhanging lobe, very slender to lamellately compressed and deepened; caudal tibiae with distal spurs (calcaria) normally consisting of two pairs but by loss occasionally reduced to a single pair (certain Morabinae). Tarsal arolia well developed.[30]

Number of Chromosomes

My friend Dr. Edwin R. Helwig, whose numerous studies on the chromosomes of the Acridoidea have added so materially to our knowledge of that aspect of Orthopteran research, has most kindly placed in my hands previously unpublished data as to the number of (male diploid) chromosomes present in those representatives of the Eumastacidae which he has studied. These figures, which should be credited in their entirety to Dr. Helwig, are: *Erianthus* sp. (Chorotypinae), 21; *Teicophrys inopinata* (Teicophryinae), 17; *Morsea californica* (Morseinae), 23; *Erucius* sp. (Eruciinae), 21; *Penichrotes*

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[30] This distinctive feature is shared with the Proscopiidae.

meridionalis (Euschmidtiinae), 19; *Amatonga spicata* (Euschmidtiinae), 19. Helwig (in litt.) has also pointed out that, " all the Tetrigidae, that I have records for, have 13 chromosomes." Similarly Dr. Helwig advises me that members of the proscopiid genera *Tetanorhynchus* and *Cephalocoema* each have 17 chromosomes. Roberts [31] has shown that the members of his Chasmosacci division of the Acrididae have 19 chromosomes and those of the Cryptosacci, with few exceptions, have 23.

From these figures it would seem that the phylogenetic evolution of the Eumastacidae has been extended over a considerable period of time; that on this count alone the family can with justice be considered a relatively ancient one, and that at least certain of its major divisions show very appreciable cytological differences, these giving an even greater range than is encountered in the numerically far larger, but no older and perhaps not as old, Acrididae. In addition the occurrence of the same chromosome number in *Teicophrys* as in *Tetanorhynchus* and *Cephalocoema* supports the evidence of certain morphological features, as indicating basic affinity of the Eumastacidae with the Proscopiidae.

Noteworthy Morphological Features of the Eumastacidae

The following comments are not offered as a comprehensive analysis of the external morphology of members of the family, such as Candido Bolívar presented in his 1930 monograph.[32] Instead they are intended as supplementary to, or as amplifications of, the discussion there given. Certain of the characters here discussed were either unknown to, or at least not considered by, Bolívar, but unless otherwise noted the present comments are to be regarded entirely as amplifications of his analysis.

Body form.—Bolívar's discussion of body form requires definite amplification, as in the subfamily Morabinae we find an attenuation of the body occasionally equal to that of the majority of the members of the Proscopiidae, and also of many attenuate genera of the Acridinae and Cyrtacanthacridinae of the Acrididae. Also an appreciable inflation of the body is found in females of the genus *Tanaocerus* of the Tanaocerotinae.[33] These extremes, added to the modifications of body form given by Bolívar, show that in the Eumastacidae we have a range in body form almost equal to that known for the numerically far more extensive Acrididae.

General form of head.—The attenuation of the head, which is a striking feature of most of the members of the Morabinae, is, of course, not mentioned by Bolívar, as he was unacquainted with that group, or did not regard it as eumastacoid. In its most extreme condition, which is found in an as yet undescribed genus from Australia, the attenuation reaches a point paralleled only in the most elongate members of the Acrididae, although in the numerous species of the better known genus *Moraba* (see figs. 11-12) we have a general superficial resemblance of the elongate head to that found in the Achuri of the acridid subfamily Acridinae.

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[31] Proc. Acad. Nat. Sci. Phila., XCIII, p. 234, (1941).

[32] Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 46, pp. xi-xxiv.

[33] See Rehn, Proc. Acad. Nat. Sci. Phila., C, pl. 1, figs. 12, 13 and 16, (1948).

Occiput.—The occiput in the members of the Morabinae possesses a feature which, to my knowledge, is unparalleled in any other group of locusts, and for which I am here using the term " basi-occipital slit." This is a linear incision, or at least very deep impression, in the median line on the dorsal occipital surface near its base, almost always free from involvement with the dorso-caudal margin of the occiput, occasionally very short and in consequence almost pit-like, but usually of a definitely linear form, and with its lateral bounding margins and its distal and proximal extremities generally slightly thickened and subcingulate (see fig. 1). Very possibly this structure is glandular, but while found in all members of the Morabinae, it is not present in other eumastacids, or in fact in any other locusts. Its position is on the line of the coronal suture, or midcranial sulcus, according to which term is used for, or interpretation placed upon, this usually evident structural feature, but its distinctive development at once sets it apart as something more than a mere sculptural deepening of this well-known grooving, which, however, is little evident elsewhere on the occiput of the forms of the Morabinae.

Fastigium.—Bolivar's analysis of the varied and complicated developments of the fastigium must be amplified to include the markedly elongate rostrate development of the same associated with the general attenuate form of the members of the Morabinae. While we have acute but relatively short rostrations of the fastigium in other genera (such as *Miraculum,*[34] *Malagassa,*[35] *Eupatrides*[36] and *Espagnola*[37]) these do not approach, in the degree of their production, what is found in numerous representatives of the Morabinae.[38]

Facial asymmetry.—Henry[39] has pointed out that facial asymmetry occurs in a number of genera of the Eumastacidae. He states that it was " shown in every one of the many specimens of *Phyllochoreia, Orchetypus, Burrinia* and several other genera " which he had examined. The asymmetry " consists in a lengthening of the right side of the face as compared with the left, and this causes the clypeus to be tilted," as shown in his figure of a female *Orchetypus rugifrons*, from Rakwana, Ceylon. He further notes that " the asymmetry extends to the mouth parts; the right lobe of the labrum is larger than the left and the right galea is much better developed than the left." His observations show that both sexes are affected, and that the asymmetry is strongly marked in *Orchetypus* and *Phyllochoreia*, distinct but not very pronounced in *Burrinia* and *Mastacides*, and very slight in *Prionacantha*.

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[34] See Burr, Genera Insectorum, Orth., Eumastacidae, pl., figs. 10a and 10b, (1903).

[35] See Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCVII, pl. 19, figs. 45-48, (1945).

[36] See C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 46, p. 153, fig. 75, p. 157, fig. 78, (1930).

[37] See Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCI, pl. 8, figs. 16 and 17,

[38] See Sjöstedt's figures of various species of *Callitala* and *Moraba:* Kungl. Svenska Vetenskapsakad. Handl., 62, no. 3, pl. 1, figs. 1-7, (1921); Ibidem, ser. 3, 15, no. 2, pl. 1, figs. 1-3, (1935); also figs. 11-12 here presented.

[39] Ceylon Journ. of Sci., (B), XXII, pt. 2, pp. 191-192, fig. 1, (1944).

I find asymmetry moderately evident in a female of *Chorotypus gallinaccus*, from Nias, and slightly to moderately developed in material representing both sexes of three species of *Hemierianthus* from West Africa (i.e. *H. forceps, batesi* and *bule*). In the available series of *Burrinia* and *Mastacides* asymmetry is not noticeable, and while not apparent in all the individuals of *Erianthus* which are before me, it is weakly indicated in some, and also in members of the genus *Mnesicles*. The New World episactid genus *Lethus* has facial asymmetry weakly indicated, and it is more evident in the single specimen before me of the Antillean genus *Espagnola* (Espagnolinae). In consequence it has been observed in genera representing six subfamilies occurring in both hemispheres.

Frontal costa.—C. Bolívar has set forth in considerable detail the modifications of the frontal costa (" quilla media frontal ") noted by him, that which may well be called the chorotypoid type, found typically developed in the Chorotypinae, being the most distinctive.[40] However, the most remarkable and unusual development of the frontal costa to be found in the family was unknown to him. This consists of the replacement of the usual acridoid type of frontal costa ventrad of the median ocellus by a single medio-vertical carina or carination, such as is found in the species of the Tetrigidae. This condition is characteristic of all members of the subfamilies Tanaocerotinae and Teicophryinae,[41] but in none of those of the other components of the Eumastacidae, or of any of the subfamilies of the Acrididae. The exact degree of phylogenetic significance of this feature remains for the future to determine, but the Tanaocerotinae and Teicophryinae are clearly two assemblages of marked divergence from the norm of the family.

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[40] See figures of the face of *Phyllochoreia equa* Burr, as given by C. Bolívar, in Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 46, p. 17, fig. 7, (1930), and of *Hemierianthus curtithorax* (Karsch), in the same work, p. 62, fig. 29.

[41] See Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCI, pl. 6, fig. 3, pl. 7, figs. 9 and 10, (1939).

Supra-clypeal triangle.—This term is here proposed for the triangular enclosure situated on the lower face ventrad of the frontal costa, when the latter is evident, and dorsad of the supra-clypeal suture (the epistomatic suture of C. Bolívar), and which is seen in many eumastacids. It is often sharply marked and carinately enclosed in this family, but may be little evident and very weakly cut off from the adjacent surface of the face. It is a feature shared with the Tetrigidae and Proscopiidae, but is absent in the Acrididae. In the family here discussed the supra-clypeal triangle is strongly developed in the Episactinae, Biroellinae, Espagnolinae, Eumastacinae, Malagassinae and Miraculinae, and in a number of genera belonging to certain other subfamilies, while it is absent in the Thericleinae and Euschmidtiinae, and in a few genera of other subfamilies. In most of the representatives of the other subfamilies which I have examined it ranges in emphasis from weak to subobsolete or absent.

Antennae.—Our present-day knowledge of the range of antennal development in the Eumastacidae is far more extensive than as summarized by C. Bolívar in 1930, in which he failed to mention a distinctive antennal feature which had been pointed out as far back as 1918. This is the presence of a rounded node or acute process, usually minute, on the ventral surface of some one of the five distal antennal articles. This was first noted by Rehn and Hebard in the above-mentioned year,[42] although they then erred in stating it was not indicated in three species of three genera, all of which have since been re-examined and the node was found to be present but minute. It is indicated in varying strength in all species of Eumastacidae, and in those representing eleven genera of the Proscopiidae, which I have examined, but I have not found it indicated in either the Tetrigidae or Acrididae. Its usual position is on the third or fourth article from the apex, less frequently on the apical one, more rarely on the second from the apex, and on the fifth from the apex in but two of nearly fifty genera which I have examined (*Teicophrys* and *Gomphomastax*). Its segmental position is not fixed within specific subfamilies, but apparently is within generic limits. While found on the distal articles in certain genera with the smallest number of antennal articles, it is also found on that article in other genera which have the greatest number of antennal articles found in the family, i.e. *Tanaocerus* (26)[43] and *Mohavacris* (27),[43] while in *Gomphomastax*, which has 23 articles, the node is on the fifth from the apex. The range in position of the node in the various subfamilies is given on subsequent pages in their individual discussion.

[42] Trans. Amer. Entom. Soc., XLIV, p. 224, footnote 2, (1918). This structure as seen in *Psychomastax* is also well figured in pl. XIII, fig. 5 of the same paper.

[43] See Rehn, Proc. Acad. Nat. Sci. Phila., C, pl. 1, figs. 12, 13, 14, 17 and 18, (1948).

In general form the antennae are filiform, subclavate,[44] ensiform or depressed. The ensiform type is not mentioned by C. Bolívar, and is characteristic of the Morabinae,[45] a group unknown to him. In cross-section the antennae of species of this subfamily are compressed triquetrous, with the lateral faces much deeper than the width of the narrow dorsal deplanation, while the dorsal and ventral marginal outlines, as seen in profile, vary specifically in the degree to which, as segmental units, they are serrate. The length of the antennae in the family has been given numerous times as "shorter than the anterior femora," although the genus *Gomphomastax* has usually been cited as an exception, and from C. Bolívar's 1930 comments he apparently felt some other genera could be considered as in the same class. As a matter of fact a number of genera have antennae which in length greatly exceed that of the cephalic femora, these including in addition to *Gomphomastax* both genera of the Tanaocerotinae (*Tanaocerus* and *Mohavacris*), both of those of the Teicophryinae (*Teicophrys* and *Cadomastax*) [46] and the majority of the members of the Morabinae. These four assemblages, however, are not intimately related, but represent three quite distinct evolutionary lines within the family.

The number of antennal articles shows a surprising range from as few as eight (in certain members of the Morabinae and in species of *Episactus*) to as many as twenty-seven (*Mohavacris*). In certain subfamilies the number of articles appears to be fixed and does not vary, while in others, such as the Morabinae, we have a range within the various species of the genus *Moraba* of from eight to eighteen, and in the Episactinae from eight to twelve, while in the broad generic range of the Thericleinae eleven are present in all of the genera which I have been able to examine.

Cervical sclerotizations.—My friend Dr. H. K. L. Key, of Canberra, Australia, a year or so past, called my attention to the presence in genera of the Morabinae of a pair of well-marked flattened sclerotic plates in the dorsal portion of the cervical membrane. The presence of such structures had not been noted previously, but I have found they are indicated in all the genera of that subfamily, although in one genus, being described in a forthcoming study of the Australian Eumastacidae, they are more elevated and nodose and less lamellate than in the others. In *Moraba*, for instance, they are well developed and of considerable size, roughly ovate in general outline, placed on each side of the median line, longitudinally subparallel in disposition, and distinctly lamellate deplanate. In no other subfamily of the Eumastacidae have I found fully comparable structures present, although in many genera, representing a number of subfamilies, a pair of rod-like, apparently tendinous longitudinal structures are evident dorsad. These, however, are not as obviously part of the cervical membrane, are not embedded in the same, and do not form marked flattened plates as in the Morabinae. In addition quite a few genera of the family have lateral structures in the cervical membrane, presumably sclerotic plates, but without sufficient wet material for examination it is difficult to do more than note the occasional presence of such features.

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[44] In *Paedomastax;* see C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 46, p. 303, fig. 149, (1930).

[45] See Sjöstedt, Kungl. Svenska Vetenskapsakad, Handl., 62, no. 3, pl. 1, figs. 1-7, (1921); Sjöstedt, Ibidem, ser. 3, 15, no. 2, pl. 1, figs. 1, 2, 3, 3a and 3b, (1935). Also figs. 11-12 of the present paper.

[46] See Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCI, pl. 6, figs. 2, 3, 4 and 6, pl. 7, fig. 10, (1939).

No attempt has been made to dissect out these dorsal plates of the Morabinae, as no wet material of that group is available at present. The observations here given are purely visual ones of dry material, but all available genera have been examined. In a number of genera of eumastacids the cephalic overhang of the pronotum is so marked that, without serious injury to the specimen, the character of the dorsal surface of the cervical membrane cannot be observed in dry material. Relaxation sufficient to permit examination of this membrane often shows that it has been damaged or has partly disintegrated in drying, particularly in smaller forms which were not eviscerated when collected. I have definitely determined from examination of dry material that dorsal cervical sclerotic plates of the type found in the Morabinae are not present in thirty-four genera of the family, while on account of pronotal overhang or close contact of head and pronotum I am unable to examine the same surface in nine other genera.

An examination of twenty-five determined species, representing eleven genera, of the Proscopiidae shows that dorsal cervical sclerotic plates are present in all of these species. It is significant that of all the divisions of the Eumastacidae the one (Morabinae) which in general appearance more nearly suggests members of the Proscopiidae, should possess this feature in common with that Neotropical family. The logical implication to be drawn from the common possession of a number of structures here considered is discussed on a subsequent page.

Pronotum.—C. Bolívar has given an analysis of the general types of pronotal development to be found in the family,[47] which needs to be amplified in but a few respects. In the genus *Tanaocerus* the pronotum is rounded transversely, moderately inflated and subbullate in the female sex,[48] in a way not found in any other eumastacid with which I am acquainted. Also, although C. Bolívar states (p. xvi) that "true lateral carinae are never present," they are well developed in the genus *Mohavacris*,[49] and also in species of several genera of the Morabinae.[50]

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[47] Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 46, pp. xv-xvii, (1930).

[48] See Rehn, Proc. Acad. Nat. Sci. Phila., C, pl. 1, figs. 12, 13 and 16, (1948).

Meso-metasterna.—C. Bolívar has graphically stated, " the meso- and metasternum in their entirety constitute a broad sternal plate." This feature is quite pronounced in the entire family, and also in the Proscopiidae, and in the great majority of the eumastacid genera examined the lateral, and frequently cephalic, definition of this ventral deplanation is sharply indicated by an encompassing carinate elevation, often obsolete only caudad. In a relatively few genera—less than half a dozen of those seen—is this cingulate border weak to subobsolete, these (i.e. *Biroella*, *Erucius*, *Burrinia*, *Erianthus* and *Espagnola*) representing at least three well-marked subfamilies. In certain genera the deplanation of this surface is in two slightly different planes, i.e. a section comprising most of the mesosternum caudad to the cephalic border of the interspace has its surface slightly ascending dorso-cephalad, while the metasternal section and the mesosternal lobes are more truly horizontal, the line of demarcation being a distinct, but not strong, straight transverse surface angulation. It is my impression a correlation of this structure will be found, in those possessing it, with peculiarities in launching themselves from certain surfaces. It is strongly marked in *Lethus*, which I know from personal acquaintance is geophilous and terrestrial, and it is also indicated to a lesser degree in *Malagassa*, of the habits of which nothing has been recorded. In other genera, such as *Plagiotriptus*, *Piezomastax* and *Brachytypus*, there is present a transverse subangulate division of the surface at the same point and in the same fashion, but without slope differentiation of the surface itself. In some other genera there is a certain amount of areal concavity, or convexity of the surface within the lateral cingulate carinae unassociated with a basic, transverse surface angulation or division into two planes.

The pleuro-sternal suture is present on both the mesothorax and metathorax in the Eumastacidae, as in the Proscopiidae.

Tegmina and wings.—As C. Bolívar has already noted, the great majority of the Eumastacidae are either completely apterous or have merely rudimentary organs of flight. In at least one genus species range from almost completely apterous to fully alate (*Eumastax*), and in a number of others from relatively micropterous or brachypterous to fully alate. In one genus (*Masyntes*) a single species (*M. gundlachii*) has been reported to be dimorphic in wing length, ranging from micropterous to brachypterous.[51]

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[49] See Rehn, Proc. Acad. Nat. Sci. Phila., C, pl. 1, figs. 17 and 18, (1948).

[50] See Sjöstedt's figures of species of *Moraba* in Kungl. Svenska Vetenskapsakad. Handl., 62, no. 3, pl. 1, particularly figs. 2 and 4, (1921).

[51] See I. Bolívar, Bull. Soc. Zool. France, I, p. 141, (1888), and discussion of the same by Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCIV, pp. 39-41, (1942).

On account of the marked prevalence of apterism in the family it does not seem desirable, at this time, to attempt any comparative study of alar development or venation, which would require ignoring the majority of the subfamilies, which are apterous or at most micro-alate, and of necessity be of any comprehensiveness solely for the few major divisions of which all, or nearly all (as in the Eumastacinae), genera are alate. Such a study conceivably could be of interest, but would be of limited usefulness in supplying evidence on the relationship and possible origin of all the major groups of the family, which is the objective at this time.

While C. Bolívar has briefly noted it (p. XVIII), I would call attention to the very distinctive and unusual type of wing development found in *Paramastax nigra*, the genotypic species of that genus. The pronounced cycloidal type wing of this species is of very ample expanse, its peripheral margin covering somewhat more than the quadrant of a circle, and this curvature is full and in no way flattened, while the wing coloration is solidly dead white, the whole a type rarely found in orthopterous insects. Some previously unpublished observations on the actions of this species and its use of its wings will be found on a following page under "Bionomics and Life Histories." C. Bolívar has noted (p. XVIII) that alar organs are developed but hidden under the enlarged and casque-like pronotum in the African genus *Plagiotriptus*. The same condition, and to an even more striking degree, is found in a species (*loricata* Rehn and Rehn[52]) of the related African genus *Piezomastax*, of which the type species (*P. carli*) possesses more evident alar organs.

General external abdominal features.—C. Bolívar has discussed these at some length (pp. XXII-XXIII). Several noteworthy aspects, however, were not mentioned or but casually referred to by him, while certain recent investigations of internal abdominal features have supplied important information on family affinities. In the Eumastacidae the development of the external genitalia of the male sex is varied and complex, but with a single exception the individual types there found are generally of little more than generic significance. In consequence with this exception analysis of these features is not presented here, as they appear to have little weight in evaluating supra-generic entities. In a following paragraph I have, however, summarized the terminology of parts of the male internal genitalia discussed by Chopard in 1920.

While the extent to which the distal abdominal tergites of the male are incised, coalesced or developed into special structures in a number of the genera has been noted to a greater or lesser degree by various students of the group, in which there is a very great diversity in the development of

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[52] Proc. Acad. Nat. Sci. Phila., XCVII, p. 209, pl. 20, figs. 49 and 50, (1945).

these areas, little has been said regarding a general condition of these segments as found in the female. In that sex several of the distal abdominal tergites immediately proximad of the supra-anal plate have on their mediodorsal line a deep longitudinal impression or fold, varying specifically in breadth and depth, while in certain species the more lateral portions of these tergites slightly overhang this central gutter-like slit. Generally the bordering margins are slightly to rather strongly diverging distad. Attention has been called to this structure in specific descriptive work, but it seems to have been neglected as a general feature of the family. It is similarly present in the female sex in the Proscopiidae, and an analogous condition is found in a number of genera of the Tetrigidae which have been examined.[53]

Spiracles.—It has been called to my attention that the abdominal spiracles in the Eumastacidae are situated in the latero-dorsal membrane, while in the Acrididae they are placed in the dorsal sclerites (or tergites). The membrane position is also found in the Tetrigidae, but in the Proscopiidae a different and more complicated arrangement is found, as while the spiracles are situated dorsad of the greater part of the ventro-lateral borders of the tergites, they are actually placed in a very small laterotergite, which is situated in an emargination of the tergal border sufficiently large to partly encircle the smaller sclerite. As Snodgrass has pointed out and well illustrated,[54] the abdominal spiracles may be placed in the tergites themselves, in the latero-dorsal membrane, in special laterotergites, or in the sternites, depending on the ventral extent of the tergites in the first case or the dorsal extent of the sternites in the last one, or when in laterotergites the extent to which these accessory sclerites are developed. In consequence, I feel their actual position in relation to the sclerotic elements involved is less significant than might be supposed.

Male genitalia.—While C. Bolívar has briefly mentioned the work of Chopard in 1920 on these structures as found in several representative eumastacid genera, the observations then made were of sufficient importance to be brought more fully before the student of the Eumastacidae, and an abstract of his findings is here given.

Chopard[55] summarized the general structure of the male genitalia, as represented by *Erianthus* and *Paramastax,* as follows: " In general, the last tergites are large, well separated, sometimes dilated, the twelfth forming a supra-anal plate [i.e. superior anal valve] entirely or not at all soldered to the preceding tergite. The subgenital plate is sometimes very deeply cut away so that the copulating organs can be seen. The latter are very variable, presenting in general a large epiphallus with two divergent branches, and a group of other pieces strongly chitinized and more or less completely soldered to each other." He figures the external and internal male genitalia of *Erianthus dohrni* and *Paramastax nigra*. As his figures show, the epiphallus and the penis and its valves are very different in these two genera, which represent quite distinct subfamilies (i.e. the Chorotypinae and the Eumastacinae). In *Erianthus* the epiphallus is said to be "very large, enlarged anteriorly, presenting in the rear a double crest garnished with five denticulations." In the same genus, "the remainder of the copulating organ forms a strongly sclerotized mass in which one can recognize neither penis nor genital valves; this single piece presents two large anterior wings and is terminated by a sort of forceps armed on each side by four long spines." In *Paramastax* it is stated "the genital pieces comprise a large epiphallus of U shape, of which each branch is divided longitudinally in its anterior part; valves and penis are united posteriorly, forming a mass of which the sides are sclerotized, with the angulate points doubtless corresponding to inferior valves, the central part membranous and bilobate, apparently representing the superior valves."

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[53] Hancock years ago (Tettig. of No. Amer., p. 5, (1902)) pointed out that in the tettigids " the ninth and tenth terga of the abdomen in both sexes are provided with a median longitudinal sulcus."

[54] Principles of Insect Morphology, p. 248, figs. 137A-137E, (1935).

[55] " Recherches sur la Conformation et le Développement des derniérs Segments abdominaux chez les Orthoptères," pp. 183-185, figs. 316, 317, 318, 319, (1920).

Regarding the noteworthy exception to the general structure of the external genitalia of the male, it is in the subfamily Morabinae where this most startling divergence from the general plan of acridoid subgenital plate development is found. In the male members of this subfamily the subgenital plate is produced into a lanceolate process, usually very elongate, and divided into two sections, one, a shorter proximal portion which has its lateral areas attingent or overlapping dorsad, and two, a lanceolate distal portion, usually very much longer than the proximal half, and which is V-shaped in transverse section. The point of juncture of the two sections is apparently a vertical hinge, and undoubtedly in life the more distal section has some freedom of lateral movement.

Distinctive features of female internal genitalia.—Slifer has shown[56] that in females of the Eumastacidae glandular pouches are absent from the cephalic end of the female genital chamber, thus agreeing with the condition found in that sex of members of the Tetrigidae and Proscopiidae studied at the same time. She also has pointed out that the spermatheca is "of a simple type and consists of a small sac attached to the end of a delicate duct which opens through the roof of the genital chamber." These spermathecal sacs, as present in *Erianthus*, *Gymnotettix* and *Malagassa*, are unusually simple, globular or pear-shaped, not with Y-shaped or filamentous tips, as in the Tetrigidae, or divided into three elongate diverticula, as in the Proscopiidae. The same author, from the evidence of five species of five genera, representing the same number of major divisions here discussed,[57] has shown in the same paper, and as later elaborated,[58] that females of the Eumastacidae possess six well-developed, finger-like diverticula or caeca attached to the hindgut not far from its cephalic end. Of approximately 340 species of Orthoptera examined by her, in studies made up to 1944, the five members of the Eumastacidae were the only ones in which caeca were found on the hindgut.

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[56] Journ. of Morph., 73, pp. 89-97, (1943).

Cephalic and median limbs.—C. Bolívar has already noted (p. XXVI) that in *Biroella,* and hence the Biroellinae, the male sex has the cephalic and median femora appreciably inflated, and the tibiae of the same limbs have their dorsal carinae developed in a somewhat different fashion from the usual eumastacid types, while the female sex lacks these sexual differentiations. The genus *Carcinomastax* Rehn and Rehn, of the Euschmidtiinae, shows similar sexual differences, with, however, the most pronounced inflation of the male femora limited to the median pair,[59] the cephalic ones being but moderately inflated, while all the tibiae show none of the specialized carinal development found in the male sex of *Biroella.* In addition to their inflation the median femora of the male in *Carcinomastax* bear a single tooth-like process on their ventral surface.

Caudal femora.—In the vast majority of the thousands of species comprising the superfamily Acridoidea, the caudal femora have at their proximal extremity, and immediately dorsad of the caudal coxae, a pronounced " overhang " or arcuate projection, the outline of which arcuately and regularly passes dorsad into the general dorsal outline of the femur. There are exceptions to this in certain groups of several subfamilies of the Acrididae, but these are greatly in the minority in that family. In the Eumastacidae, however, the majority of the genera do not possess this " overhang," the dorsal femoral outline passing evenly distad from the coxal articulation without any such gable-like development (see fig. 2). The marked development of the " overhang " in the family is found only in the Thericleinae (see fig. 10) and certain genera of the Chorotypinae. Taken broadly the Eumastacidae more consistently lack this " overhang " than any other family or subfamily of the Acridoidea except the Proscopiidae and Pneumoridae, the former of which seems never to have the " overhang," while the caudal limbs in the latter are of a radically different and more generalized pattern. As discussed elsewhere in this paper, I feel there is a correlation of the presence or absence of this "overhang" with ability to rotate the coxae and the mechanics involved in the use of the caudal limbs saltatorially.

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[57] *Erianthus guttatus* (Chorotypinae), *Erucius* sp. (Eruciinae), *Eumastax surinama* (Eumastacinae), *Gymnotettix lithocolletus* (Episactinae), and *Malagassa* sp. [=*M. tridens*, since described] (Malagassinae).

[58] Ann. Entom. Soc. Amer., XXXVIII, pp. 441-446, (1944).

[59] Proc. Acad. Nat. Sci. Phila., XCVII, pp. 221-234, text-figs. 19 and 20, pl. 20, figs. 53 and 54, (1945).

Caudal tibiae.—While the spines of the internal extensor margin of the caudal tibiae are as a whole biseriate in length, i.e. in an alternating longer and shorter arrangement, in the majority of the genera of the Eumastacidae, in the genera of the Thericleinae and of the Euschmidtiinae which I have examined, they instead regularly decrease in length proximad and distad from a median area with spines of maximum length, while in the Tanaocerotinae, the Gomphomastacinae and in certain genera of the Morabinae and of the Morseinae they are virtually uniform in length throughout the series.

Henry has recently pointed out[60] that the caudal tibial spines and spurs, and the tarsal claws, are serrated in *Ebneridia, Erianthus* and *Prionacantha*, that the tibial spurs and tarsal claws are similarly sculptured in *Erucius*, and that the tarsal claws alone are serrated in *Burrinia, Phyllochoreia* and *Mastacides*. He also notes that in *Eupatrides* and *Gomphomastax* neither spines nor claws are serrated. Of the genera mentioned I have checked, and support, his conclusions in connection with all these genera except *Prionacantha* and *Phyllochoreia*, which are not available at present. In addition I have examined a considerable number of genera not seen by him, and where specialization was found it has been noted in the analysis of subfamilies here presented.

Candido Bolívar (p. XXI) first pointed out that in the genus *Biroella* there is a departure from the almost universal acridoid type of development of the distal spurs of the caudal tibiae. He noted that, in species of *Biroella* examined and mentioned by him, on the internal face two spurs were present, the flexor one, however, greatly reduced in size, and while on the external face the extensor one was normal and large, the flexor one was very greatly reduced in size, being microscopic and spiniform, yet clearly an articulate spur. I find in paratypic material before me, representing four forms of the genus, that from this condition in some species at least one other member of that genus (i.e. *B. papuanus* C. Bolívar[61]) diverges to the point where it has the flexor external spur completely absent. I have also found in the course of my Australian studies that in the Morabinae there is a progressive reduction in the size or number of the distal tibial spurs, until in the extreme condition, which is found in the genus *Callitala* and an as yet undescribed one, but a single spur is present on each side, this being the extensor (see figs. 6-7). In the various species of the genus *Moraba* there is but one external spur present, and the flexor internal one may be minute, straight and spiniform, or completely absent. In a reversal of the condition found in the Morabinae and the Biroellinae, in the Euschmidtiinae two external spurs are always present (that is in the genera of the subfamily, of which I have been able to examine material), while of the internal pair the flexor is lost in *Amatonga* and *Amalomastax* (see figs. 8-9), is present but minute and spiniform in *Carcinomastax*, and larger, but yet very greatly reduced and not typically calcariform in *Euschmidtia*. It is evident from the above that factors influencing the reduction of the flexor calcaria, have apparently operated in different directions in groups of genera which I am here considering as representative of approximate extremes in the family.

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[60] Trans. Entom. Soc. London, XC, p. 501, footn. 1, (1940).

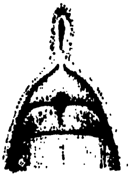
[61] I have before me in the Academy series a paratypic pair received in exchange from the Berlin Zoological Museum.

Caudal tarsi.—The general modifications of the marginal spination of the caudal metatarsus have been reviewed by C. Bolívar (p. xxii). However, he has not noted that in certain genera the dorsal surface of the metatarsus is not sulcate or excavate longitudinally, and may be simply deplanate with the margins spined (Eumastacinae) or unarmed (as in certain, but not all, genera of the Morabinae and Thericleinae). Again the dorsal surface of the metatarsus may be low carinate medio-longitudinally, the whole subtectate in transverse section and without marginal armament, as in the Tanaocerotinae (see fig. 5), or even rounded transversely with the lateral margins unarmed, as in an as yet undescribed genus of the Morabinae.

The tarsal claws may be equal or unequal in length; in the latter case the caudal one is always the longer. This variation, however, seems to me to be largely adaptive, and while individual genera are consistent in the pattern, two genera of otherwise close relationship may differ in the equal or unequal size of the tarsal claws.

Provisional Key to Subfamilies

The following key is presented with full realization of its artificial and tentative character, of the exceptions which are included, and its apparent reliance in various couplets upon features which are known to be variable in other categories here discussed. I feel, however, it is definitely a better basis for future work than that given by Candido Bolívar in 1930. In relation to the exceptions which are cited in a number of places, further reference in other couplets to the categories mentioned will, I feel, permit the proper reference of material.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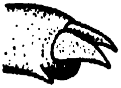
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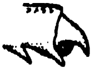
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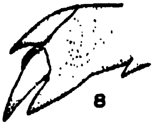
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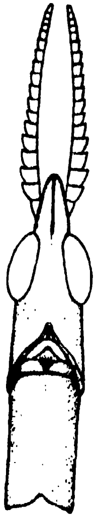
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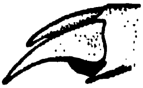
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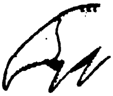
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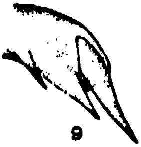
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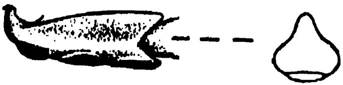
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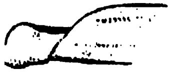
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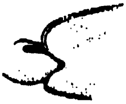
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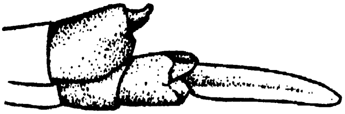
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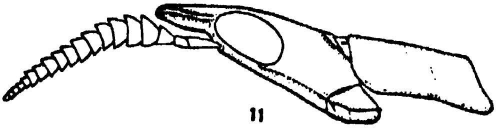
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Moraba granulosa Sjöstedt. Female (type). Ooldea, South Australia. Fig. 1.—Basi-occipital slit and cervical sclerotizations of female (type), as seen from dorsum. (Greatly enlarged.) Fig. 2.—Proximal extremity of caudal femur, showing lack of dorso-proximal overhang. (Greatly enlarged.)

Moraba serricornis Walker. Female. Groote Eylandt, Northern Territory, Australia. Fig. 11.—Lateral view of head and pronotum. (× 4.) Fig. 12.—Dorsal view of head and pronotum. (× 4.) Male. Groote Eylandt, Northern Territory, Australia. Fig. 13.—Lateral view of apex of abdomen. (Greatly enlarged.)

Tanaocerus k. koebelei Bruner. Female. Road to Charleston Peak, Nevada. Fig. 3.—External spurs of caudal tibia. (Greatly enlarged.) Fig. 4.—Internal spurs of caudal tibia. (Greatly enlarged.) Fig. 5.—Caudal metatarsus and cross-section of same. (Greatly enlarged).

Callitala brevirostris Sjöstedt. Female. Port Darwin, Northern Territory, Australia. Fig. 6.—External spur of caudal tibia. (Greatly enlarged.) Fig. 7.—Internal spur of caudal tibia. (Greatly enlarged.)

Amalomastax lambertoni Rehn. Female (paratype). Roges District, Madagascar. Fig. 8.—External spurs of caudal tibia. (Greatly enlarged.) Fig. 9.—Internal spur of caudal tibia. (Greatly enlarged.)

Brachytypus burri Rehn. Female (paratype). Mossamedes Province, Angola. Fig. 10.—Proximal extremity of caudal femur, showing dorso-proximal overhang. (Greatly enlarged.)

It may be argued that too many subfamilies are here recognized, and that an unwarranted number of new ones have been created. My reply would be that in his more recent papers Bolívar has combined certain subfamilies which had been previously erected, and it is my belief that at least one of these instead is a natural and logically classificatory entity entitled to subfamily rank (Eruciinae). Again a number of the subfamilies here recognized were unknown to Bolívar from material (i.e. Tanaocerotinae, Teicophryinae, Morabinae, Morseinae and Espagnolinae), while numerous genera of the Eumastacinae, Episactinae and Euschmidtiinae since described, and now before me, were not available to him. Conversely I have not been able to examine material of certain African, Indo-Malayan and Asiatic genera, although all known New World genera except one (i.e. *Parepisactus*), and all known from Australia are now before me in the collections at the Academy, or in others now in hand for study (in the case of the Australian genera).

With this word of explanation I am submitting this key to be tested by others, as well as in my own future work, in the hope that it will prove to have a constructive basis, utilizing on one hand certain characters which have not been used at all in eumastacid classification, and on the other reducing the emphasis which has been placed on some features as orthodox criteria, but which we now know to be of less fundamental importance.

1. Basi-occipital slit present (see fig. 1). Flexor (second) internal caudal tibial spur minute and spiniform, or completely absent (see figs. 6-7). Cervical membrane dorsad with paired flattened sclerotized plates (these rarely tuberculose on dorsal surface) (see fig. 1). Antennae (with 8-18 articles) ensiform to subensiform (see figs. 11-12), not filiform or clavate distad. Subgenital plate of male composed of two linearly horizontally disposed parts, the distal articulating laterally on the proximal (see fig. 13). (Apterous. Form generally elongate and truxaloid, or even proscopioid. Antennal node on distal or antepenultimate article. But one external caudal tibial spur present.) .... **Morabinae** new subfamily

   Basi-occipital slit absent. Flexor (second) internal caudal tibial spur always present and of normal calcariform type, even if reduced in size, except in certain genera of the Euschmidtiinae, which see. Cervical membrane dorsad without paired flattened sclerotized plates. Antennae filiform, or clavate distad, never ensiform nor subensiform. Subgenital plate of male of various types, but never composed of two linearly and horizontally disposed parts articulating one on the other. 2

2. Flexor (second) external caudal tibial spur reduced to a minute spine, often very difficult to see, or (occasionally) absent. (Apterous to brevialate. Form moderately robust. Head without rostrate fastigium. Antennae simple and filiform, with 18 articles, node on

fourth from apex. Flexor (second) internal caudal tibial spur present and of normal type, but small. Caudal metatarsi with dorsal surface excavate, their lateral margins not definitely spined, but with a single tooth at base of external one.) .... **Biroellinae**

Flexor (second) external caudal tibial spur not spiniform, always present as a normal calcariform structure. 3

3. Frontal costa with portion ventrad of median ocellus consisting of a single median vertical carina (as in the Tetrigidae). (Apterous. Supra-clypeal triangle developed but of varying emphasis. Antennae with 23-27 articles. Surface of fastigial dorsum continuous with that of sulcation of dorsal portion of frontal costa, even if over the apex of a low fastigial process (as in *Teicophrys*). 4

Frontal costa of normal type (mesad sulcate to subsulcate throughout, with lateral bounding carinae or carinulae). 5

4. Antennae exceedingly elongate, surpassing body length in male, individual articles markedly elongate throughout, node on distal article. Subgenital plate of male composed of two or three subparallel sclerotized elements united by membranes. Spines of internal margin of caudal tibiae not biseriate in length, instead regularly reducing in length proximad and distad. Caudal metatarsi dorsad mediolongitudinally carinate, subtectate in cross-section, margins not spined (see fig. 5). (Antennal articles numbering 26-27.)
Tanaocerotinae new subfamily

Antennae of medium length, never equal to body length in either sex, individual articles not elongate throughout, node on penultimate or fifth article from apex. Subgenital plate of male a single sclerite, often poculiform. Spines of internal margin of caudal tibiae as a whole biseriate in length, with four distal ones of subequal length. Caudal metatarsi excavate dorsad, both dorsal margins, or internal only, spined. (Antennal articles numbering 23-26.)
Teicophryinae new subfamily

5. Antennae with articles ranging in number from 9 to 25, but usually more than 18; antennae clavate or subclavate distad, except in genus *Pielomastax*, in which also the articles number but 9. (Apterous.[62] Male subgenital plate entire, or nearly so, poculiform. Caudal metatarsi narrowly sulcate medio-dorsad, both lateral margins spined.) .... **Gomphomastacinae**

Antennae usually with not more than 14 articles (then only in the Malagassinae and Miraculinae (17-18) and Euschmidtiinae (up to 16)), the articles never individually elongate and the whole rarely clavate at the apices.[63] 6

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[62] Chang (Notes Entom. Chinoise, IV, p. 44, (1937)), in describing *Pielomastax*, refers to the organs of flight as being "represented by minute rudiments in Gomphomastoids." I have seen no evidence of their presence in the genera of the subfamily which I have examined.

[63] The aggregation here included under this alternative couplet is very diverse in many respects, and occasionally in part violates certain other groupings. In couplets 17 and 18 the fastigium in some genera is somewhat rostrate produced, and in the Euschmidtiinae the flexor (second) internal caudal tibial spur is greatly reduced or lacking.

6. Flexor (second) internal caudal tibial spur much reduced, minute or lacking (see figs. 8-9). (Apterous to brevialate. Antennae with 15-16 articles; node on penultimate, antepenultimate or preceding (fourth from apex) article. Supra-clypeal triangle absent. Caudal metatarsi dorsad sulcate-excavate longitudinally, lateral margins carinate, external distal spine only one present.)

Euschmidtiinae new subfamily

Flexor (second) internal caudal tibial spur normally developed. 7

7. Antennal articles numbering 17-18. Fastigium rostrate and greatly produced into either an attenuate conical process or a subequally wide one with a transverse crescentic forked apex. (Supra-clypeal triangle marked.) 8

Antennal articles numbering not more than 14, usually less. Fastigium variously developed, but not produced in a marked conical process or one with a crescentic forked apex 9

8. Antennal articles simple. Fastigium conical and tapering. Dorsal surface of abdomen lacking specialized processes. ...... **Malagassinae**

Antennal articles individually subtriquetrous. Fastigium with greater portion narrow and of subequal width, apex transversely and markedly crescentic furcate. Dorsal surface of abdomen with specialized processes. .... **Miraculinae**

9. Caudal femora with pronounced dorso-proximal overhang (also in Chorotypinae in opposite category) (see fig. 10). Frontal costa very narrow, sulcate. (Apterous to brevialate. Form compressed. Fastigium with well-developed sublamellate lateral margins. Face deplanate to a greater or lesser degree. Supra-clypeal triangle not evident. Antennae with 11 articles; node on penultimate or antepenultimate article. Lateral meso-metasternal cingulations marked. Subgenital plate of male simple, fully sclerotized. Spines of internal margin of caudal tibiae not biseriate in length, the series decreasing in individual length proximad and distad. Caudal metatarsi sulcate-excavate medio-dorsad, lateral margins carinate and unspined except for one disto-external spine.) .... **Thericleinae**

Caudal femora, except in Chorotypinae, with at most a very slight dorso-proximal overhang, this usually lacking. Frontal costa never as narrow as in alternate category. (Antennae with from 8-12 articles. Fastigium variously developed.) 10

10. Apterous, or at most micro-alate (latter condition also found in certain genera of the Eumastacinae which is placed under the opposite category). 11

Alar organs usually fully developed, and functional (rarely reduced or lacking in a few genera of the Eumastacinae). 13

11. Apterous. Supra-clypeal triangle pronounced. Dorsal surface of caudal metatarsi excavate dorsad with both margins spined. (Antennae with 8-12 articles, node on distal one. Male subgenital plate entire, poculiform, fully sclerotized. Fastigium but little produced, with a transverse apical carina.) .... **Episactinae**

Apterous (Morseinae) to micro-alate (Mastacideinae). Supra-clypeal triangle weak or even subobsolete. Dorsal surface of caudal metatarsi narrowly excavate to sulcate mesad, at least internal margin unspined. 12

12. Apterous. Antennae with 12-13 articles. Fastigium with dorsal surface cut off to a variable degree from that of the sulcation of the frontal costa by a low transverse carinula. Male subgenital plate with dorso-distal rim alone sclerotized, large proximo-median section membranous. .... **Morseinae** new subfamily

Micro-alate. Antennae with 11 articles, somewhat enlarged distad, proximal article elongate. Fastigium very narrow, compressed, dorsal surface narrowly continuous mesad with that of the sulcation of the frontal costa. Male subgenital plate entire, poculiform, fully sclerotized. .... **Mastacideinae** new subfamily

13. Caudal metatarsi with both lateral margins of dorsal surface markedly spined. (Fastigium rostrately produced, completely interrupting the continuity of the dorsal surface of the fastigium with the sulcation of the frontal costa. Lateral meso-metasternal cingulations hardly evident. Male subgenital plate membranous at base.)
Espagnolinae new subfamily

Caudal metatarsi never with both lateral margins of dorsal surface markedly spined. 14

14. Caudal tibial spurs with flexor (second) one on each side usually small to very small. Caudal metatarsi with dorso-lateral margins serrulate carinate. Male subgenital plate never divided into two lateral parts and never having accessory appendages. (Fully alate (in most species) to micro-alate. Antennae with 12-14 articles, node on fourth article from apex. Spines of internal margin of caudal tibiae biseriate in length.) .... **Eumastacinae**

Caudal tibial spurs with flexor (second) one on each side of normal size and development. Caudal metatarsi with at least one of the dorsolateral margins spined completely or in part, never only serrulate. Male subgenital plate with accessory appendages (Chorotypinae) or divided in two to base. 15

15. Spines of internal margin of caudal tibiae not biseriate in length. (Supra-clypeal triangle obsolete. Fastigium weakly produced, with a substrumose transverse carina cephalad, surface of dorsum of fastigium separated from that of frontal costa. Caudal margin of pronotal disk angularly produced. Lateral meso-metasternal cingulations marked. Caudal femora with shallow dorso-proximal overhang. Spines of internal margin of caudal tibiae very weakly sublamellate.) .... **Chininae**

Spines of internal margin of caudal tibiae biseriate in length. 16

16. Structure rather fragile and subpapilionaceous in *Erucius*, form less compressed, sexual dimorphism in general form little evident or virtually absent. Antennae with node on fourth article from apex. Fastigium little, if at all, produced (only in *Prionacantha*), in profile more regularly passing, by a variable width channel, over the

fastigio-facial point to the sulcation of the frontal costa. Face hardly deplanate. Frontal costa at most but weakly scutellate in the interantennal region. Alar organs membranous to submembranous. (Lateral meso-metasternal cingulations subobsolete to obsolete cephalad.) .... **Eruciinae**

Structure more robust, form more compressed, often very decidedly so, sexual dimorphism in general form definitely evident or very pronounced. Antennae with node on antepenultimate article. Fastigium in form ranging from transversely produced trigonal to definitely rostrate, in the former case with a transverse carina at the fastigio-facial angle, dorsal surface of the fastigium completely cut off from that of the frontal costa. Face deplanate. Frontal costa definitely to very decidedly scutellate in the inter-antennal region. Tegmina in female usually subcoriaceous to coriaceous (rarely submembranous). (Caudal femora with or without marked dorso-proximal overhang. Male subgenital plate either divided to base into two parts, or not divided but with accessory processes.) **Chorotypinae**

Systematic Arrangement, Features, Distribution and Components of Subfamilies

The arrangement here presented is the result of an exhaustive and critical study of material representative of all the subfamilies discussed except the Miraculinae, which I have not seen. As with the preceding key I realize it is open to numerous criticisms, and doubtless will have some alterations made in it by workers in the not distant future, but I believe it is fundamentally sound, and that it presents a more truly phylogenetic classification than any previously proposed for the group. I regard each subfamily as a natural entity, with future subdivision more probable than combinations of any here discussed.

There is given under each subfamily a reference to the first paper in which group value was given to that entity. To each subfamily I have appended, with their original references and genotypes, those genera which I would place definitely in that subfamily, as well as similar data on genera unknown to me from material but which, at least tentatively, I would place in that particular aggregation. Genera of which I have examined material have their names preceded by an asterisk.

The sequence in which the subfamilies are presented is that in which I would arrange them in a linear classification. Due to the inherent limitations of a one dimension presentation this cannot be completely phylogenetic. Following the discussion of the various subfamilies, however, there will be found a diagram which gives my conception of the phylogenetic relationship of the various entities.

Subfamily MORABINAE new name

1903. *Psednurinae* Burr, Genera Insectorum, fam. Eumastacidae, pp. 3, 22.

The Psednurinae as proposed by Burr in 1903 was based on the genus *Psednura*, there erected on two species from Tasmania, i.e. Erichson's *Truxalis viatica* and his *Mesops pedestris*, both described in 1842. These are now known to be widely different insects, of which the former is a eumastacid, but unfortunately Burr indicated no type for his genus, and the first selection was made by Kirby in 1910, who indicated *Mesops pedestris* as the type of *Psednura*. This ties the generic name to a crytacanthacridine acridid,[63a] which removes it from consideration as the basis of a subfamily name for the present assemblage. The generic name *Moraba*, however, is that of the typical and most diversely developed member of this subfamily, and the name here used has been formed from it.

General features.—Form elongate, subacilliform, subproscopoid or vilernoid. Apterous. Head rostrately produced, fastigium truxaloid and severing continuity of dorsal surface and frontal costa. Frontal costa of basic bicarinate acridoid type, supra-clypeal triangle weak to absent. Antennae ensiform to subensiform, triquetrous in section, articles ranging from 8 to 18 in number, node on distal or antepenultimate article. Basi-occipital slit present. Cervical membrane with pronounced paired dorsal sclerotic plates (rarely their surface nodose). Pronotum with caudal margin V-emarginate. Meso-metasternal cingulations marked. Male subgenital plate composed of two linearly disposed, laterally articulate parts, the distal cultriform. Caudal femora lacking a dorso-proximal overhang. Spines of internal extensor margin of caudal tibiae ranging from subuniform in length (*Callitala*) to moderately biseriate (*Moraba*); caudal tibial spurs with usual flexor (second) external one always lacking, flexor (second) internal reduced and spiniform or entirely lacking. Tibial spines and spurs and tarsal claws with margins simple and unspecialized. Caudal metatarsi dorsad ranging from subdepressed to medio-longitudinally sulcate on one hand, to rounded transversely on the other. Tarsal claws ranging in relative length from equal (*Moraba*) to unequal (*Callitala*).

Distribution.—Australia and Tasmania (the latter solely on the basis of Erichson's original record of *Moraba viatica*).

Included genera:

**Callitala* Sjöstedt, Kungl. Svenska Vetenskapsakad. Handl., 62, no. 3, pp. 21, 27, (1921). Genotype (by original designation).—*C. major* Sjöstedt.

**Moraba* Walker, Catal. Derm. Salt. Brit. Mus., III, p. 505, (1870). Genotype (by monotypy).—*M. serricornis* Walker.

Additional undescribed genera will be characterized in a forthcoming revision of the Australian Eumastacidae.

[63a] The genus *Psednura* Burr, with *Mesops pedestris* as its type, is the earliest name for the genus to which Sjöstedt much later (Kungl. Svenska Vetenskapsakad. Handl., 62, no. 3, pp. 84, 104, (1921)) applied that of *Betisca*, with Erichson's *pedestris* its genotype by monotypy. Sjöstedt's generic name, therefore, falls as a direct synonym of *Psednura* Burr, 1903.

Subfamily TANAOCEROTINAE new subfamily

The genus *Tanaocerus*, proposed by Bruner in 1906, was originally considered to belong to the Eremobiini of the Oedipodinae, along with certain other North American genera, which latter it is now known belong to the endemic New World subfamily Romaleinae of the Acrididae.[64] The position of *Tanaocerus* remained problematical, but it is now fully evident that it and the recently described *Mohavacris* represent a very aberrant subdivision of the Eumastacidae, possessing among other things the proportionately longest antennae known to be found in any acridids, while the structure of the frontal costa approaches that of the Tetrigidae, and is shared in the Eumastacidae solely with the following subfamily, the Teicophryinae. A comprehensive discussion of the two genera composing the Tanaocerotinae was recently presented by the author.[65]

General features.—Form of male moderately elongate, of female (where known) relatively robust. Apterous. Head broad and oedipodoid in female, fastigium little produced, narrowing cephalad, its dorsal surface sulcately passing to dorsal section of frontal costa, which latter is narrowly sulcate dorsad, but ventrad of median ocellus consists of a single tetrigoid carinate ridge; supra-clypeal triangle weak to absent. Antennae filiform, very greatly elongate in male, there much surpassing body length, shorter in female but in that sex (where known) always exceeding the length of the caudal femur, articles, except proximal two, individually elongate moniliform, 26-27 in number, node on distal article. Pronotum with or without distinct lateral carinae. Meso-metasternal cingulations marked. Subgenital plate of male composed of two or three vertically disposed lamellae, membranously connected. Caudal femora lacking a true dorso-proximal overhang, but with articulating surface concave. Spines of internal extensor margin of caudal tibiae uniform or subuniform in length; caudal tibial spurs of usual 2:2 development. Caudal metatarsi medio-longitudinally carinate dorsad, tectate in transverse section, no marginal spines. Tarsal claws of equal length. Margins of caudal tibial spines, caudal tibial spurs and of tarsal claws unspecialized.

Distribution.—Southwestern United States and northern Baja California, Mexico.

Included genera:

* *Tanaocerus* Bruner, Biol. Cent.-Amer., Orth., II, p. 191, (1906). Genotype (by monotypy).—*T. koebelei* Bruner.

* *Mohavacris* Rehn, Proc. Acad. Nat. Sci. Phila., C, p. 17, (1948). Genotype (by original designation).—*M. timberlakei* Rehn.

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[64] See Roberts, Proc. Acad. Nat. Sci. Phila., XCIII, p. 239, (1941).

[65] Proc. Acad. Nat. Sci. Phila., C, pp. 1-22, figs. 1-17, (1948).

Subfamily TEICOPHRYINAE new subfamily

1939. *Teicophryes* (group) Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCI, pp. 168, 169.

While the distinctive character of the genera here placed in this subfamily was recognized in 1939 (vide supra), their agreement in certain respects with the genus *Tanaocerus*, here placed in the new subfamily Tanaocerotinae, was not then appreciated, chiefly because the male sex of *Tanaocerus* was then unknown and but few individuals of the genus were in any collection. The situation today is quite different.

General features.—General form as typical for the family. Apterous. Fastigium but moderately or not at all produced, not interrupting continuity of dorsal surface of fastigium with dorsal portion of frontal costa, latter subscutellately broadened and sulcato-excavate ventrad to median ocellus, thence ventrad brief and unicarinate; supra-clypeal triangle weak to subobsolete. Antennae moderately elongate, at least one and one-half times as long as cephalic femora, filiform, 23-26 articles, node varying in position from penultimate article to fifth from apex. Meso-metasternal cingulations marked. Subgenital plate of male simple, poculiform, fully sclerotized. Caudal femora lacking a distinct proximo-dorsal overhang.[66] Spines of internal extensor margin of caudal tibiae largely biseriate in length; caudal tibial spurs 2:2, but flexor (second) external much reduced in size, yet calcariform and not spiniform in type. Caudal metatarsi excavate dorsad, with both or external one alone spined. Tarsal claws of equal length. Margins of tibial spines, of caudal tibial spurs and tarsal claws unspecialized.

Distribution.—South-central and southern Mexico and the Cape (southern) region of Baja California, Mexico.

Included genera:

* *Cadomastax* Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCI, p. 170, text-figs. 1 and 2, pl. 6, figs. 1-3, (1939). Genotype (by original designation).—*C. robertsi* Rehn and Rehn.

* *Teicophrys* Bruner, Biol. Cent.-Amer., Orth., II, p. 20, 2 text figs., (1901). Genotype (by monotypy).—*T. fusiformis* Bruner. Genus recharacterized by Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCI, p. 175, (1939).

Subfamily GOMPHOMASTACINAE

1899. *Gomphomastaces* Burr, Anales Soc. Españ. Hist. Nat., XXVIII, pp. 81, 89, 94, 107.
1903. *Gomphomastacinae* Burr, Genera Insectorum, Eumastac., pp. 2, 9.

I am tentatively including in this assemblage the genera *Brachymastax* Ramme and *Pielomastax* Chang, although I am by no means convinced that this is their natural position, as both show certain tendencies which suggest the next subfamily, the Morseinae. The first of these genera is known to me only by its quite inadequate original description, and the second solely from a little very imperfect material. In addition I am by no means certain that all of the species which have been referred to the genus *Gomphomastax* are really congeneric. Further the genus *Paedomastax* C. Bolívar is so divergent from true *Gomphomastax* that without material I cannot feel satisfied as to the correctness of its subfamily assignment. Hence the statement of features for the Gomphomastacinae here given may require revision when these dubious genera have been reexamined.

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[66] While no true overhang is present, this surface is more subvertically truncate in both included genera than in other eumastacids which do not possess a pronounced overhang.

General features.—Form typically eumastacoid, but occasionally quite short and stout (*Brachymastax*). Apterous. Fastigium not at all produced, broad and its surface plane to deeply excavate (*Brachymastax*), more or less separated from frontal costa by a weak transverse low subangulation, or continuous arcuately with same (*Paedomastax*); frontal costa throughout sulcate, carinately margined; supra-clypeal triangle weak to obsolete, always low and transverse when apparent. Antennae ranging from relatively elongate to but little longer than head and pronotum,[67] slender to thickened (*Brachymastax*), articles ranging from 9 (*Pielomastax*) to 25 (*Gomphomastax*) in number, apex simple or broadened, node on fifth article from apex.[68] Meso-metasternal cingulations marked. Subgenital plate of male simple, poculiform. Caudal femora lacking a proximo-dorsal overhang. Spines of internal extensor margin of caudal tibiae decreasing in length proximad and distad and not biseriate in length (*Gomphomastax*), or irregularly biseriate in length (*Pielomastax*); caudal tibial spurs normal, 2:2. Caudal metatarsi sulcate dorsad, both margins spined. Tarsal claws unequal (*Gomphomastax* and *Pielomastax*). Margins of tibial spines, of caudal tibial spurs and of tarsal claws unspecialized.

Distribution.—Central and eastern Asia, from Turkestan and northern Afghanistan, south across Kashmir to the Punjab, and eastward to coastal China (Kiangsi and Chekiang Provinces).

Included genera:

**Gomphomastax* Brunner, Abhandl. Senckenb. Gesell., XXIV, p. 232, (1898). Genotype (by selection of Burr, 1899).—*G. antennatus* Brunner.

Paedomastax C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 46, pp. 288, 303, (1930). Genotype (by original designation).—*Gomphomastax constrictus* Brunner.

Brachymastax Ramme, Mitt. Zoolog. Mus. Berlin, XXIV, p. 127, (1939). Genotype (by original designation).—*B. afghanus* Ramme.

**Pielomastax* Chang, Notes d'Entom. Chin., IV, p. 41, (1937). Genotype (by original designation).—*P. octavii* Chang.

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[67] In *Gomphomastax* the antennae are typically quite elongate, longer than the cephalic femora, while in *Paedomastax* and *Brachymastax* they are said to be little longer than the head and pronotum, and in *Pielomastax* shorter than the cephalic femora.

[68] I have been able to examine antennae of only *Gomphomastax clavatus*, and in consequence this comment on the position of the node is drawn solely from that species.

Subfamily MORSEINAE new subfamily

The genera placed in this new subfamily were previously regarded as members of the Eumastacinae, which we now know is a purely Neotropical group. Nearest affinity of the Morseinae is with the Asiatic Gomphomastacinae, and certain genera (*Brachymastax* and *Pielomastax*) here included in the latter group show tendencies toward the present subfamily. However, the genera placed in the Morseinae are relatively cohesive, while those of the Gomphomastacinae are much more diverse; the former is very clearly a natural group, whereas the Gomphomastacinae as here discussed is much less so.

General features.—Form typically eumastacoid. Apterous. Fastigium but moderately produced, its dorsal surface cut off from that of frontal costa by a transverse carinula at the fastigio-facial angle; frontal costa throughout sulcate, relatively broad dorsad, subconstricted at paired ocelli, carinately margined; supra-clypeal triangle low and broad to subobsolete. Antennae shorter than combined length of head and pronotum, slightly to distinctly enlarged distad, articles 12 to 13 in number, node on antepenultimate or next article proximad. Meso-metasternal cingulations marked. Subgenital plate of male with encircling dorso-distal rim sclerotized, large proximo-median area membranous. Caudal femora lacking a proximo-dorsal overhang. Spines of internal extensor margin of caudal tibiae ranging in length from moderately biseriate to regularly decreasing in length proximad and distad; caudal tibial spurs normal, 2:2, but flexor (second) on each side small. Caudal metatarsi finely sulcate dorsad, margins low carinate but not spined. Tarsal claws unequal. Margins of tibial spines, of caudal tibial spurs, and of tarsal claws unspecialized.

Distribution.—Southwestern United States, north to central California and Nevada, east to Utah and Arizona. Doubtless occurs in extreme northern Sonora and Baja California, Mexico. Largely thamnophilous in habits.

Included genera: [69]

**Psychomastax* Rehn and Hebard, Trans. Amer. Entom. Soc., XLIV, pp. 225, 242, (1918).[70] Genotype (by original designation).—*P. psylla* Rehn and Hebard.

**Eumorsea* Hebard, Trans. Amer. Entom. Soc., LXI, p. 119, (1935). Genotype (by original designation).—*E. balli* Hebard.

**Morsea* Scudder, Psyche, VIII, p. 179, (1898). Genotype (by monotypy).—*M. californica* Scudder.

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[69] The genera here included may be separated by the key given by Rehn and Rehn in 1942 (Proc. Acad. Nat. Sci. Phila., XCIV, pp. 4 and 5).

[70] A review of the forms of this genus was published by Hebard in 1934 (Trans. Amer. Entom. Soc., LIX, pp. 363-370, pl. XXII, figs. 1-6).

Subfamily MASTACIDEINAE new subfamily

This subfamily includes but a single genus, as far as known, and the relationship of the latter was considered debatable by Candido Bolívar in 1930, although he placed it in the Eruciinae, in which (as the Erucii) it had also been placed by Burr in 1899 and 1903. In certain respects this genus resembles the Morseinae, and in others the Eumastacinae, but the sum total of its features requires the creation of a distinct subfamily for its reception.

General features.—Form typically eumastacoid. Micro-alate, tegmina lateral, wing rudiments either covered by tegminal slips or exposed. Fastigium compressed, little produced, dorsal surface of same lineately continuous as a sulcus over fastigial angle with narrowly sulcate frontal costa, lateral borders of fastigial angle sublamellate to thickened and subbulbously inflated; frontal costa narrow but normal, finely sulcate and laterally carinate; supra-clypeal triangle distinct to weakly indicated. Antennae shorter than length of head and pronotum combined, somewhat thickened distad, composed of 11 articles, node on antepenultimate one. Meso-metasternal cingulations marked. Subgenital plate of male entire, poculiform, simple. Caudal femora lacking a proximo-dorsal overhang. Spines of internal extensor margin of caudal tibiae biseriate in length with second to fourth from apex relatively short and uniform; caudal tibial spurs normal, 2:2. Caudal metatarsi excavate dorsad, external margin unarmed, internal denticulate. Tarsal claws unequal. Margins of tibial spines, of caudal tibial spurs and of tarsal claws unspecialized.

Distribution.—Southern India.

Included genus:

**Mastacides* I. Bolívar, in Burr, Anales Soc. Españ. Hist. Nat., XXVIII, pp. 94, 111, (1899). Genotype (by original designation).—*M. pupaeformis* I. Bolívar.

Subfamily EUMASTACINAE

1899. *Eumastaces* Burr, Anales Soc. Españ. Hist. Nat., XXVIII, p. 257.
1903. *Eumastacinae* Burr, Genera Insectorum, fam. Eumastacidae, pp. 2, 15.

While this division formed part of Stål's Mastacidae, Karsch's Mastacina, and Brunner's Mastaces, it was first recognized in virtually the sense here used by Burr in 1899 as the group Eumastaces; in 1903 the same author gave subfamily rank to the assemblage, which retained the same coverage until the present. Certain genera, previously regarded as members of the Eumastacinae, are here removed to the newly constituted Morseinae.

General features.—Form typically eumastacoid, relatively slender. Micro-alate (infrequent), brevialate to fully alate, wings occasionally cycloid (in species of *Paramastax*). Fastigium never produced, narrowly rounded over fastigio-facial angle or with low lateral nodes (*Eumastacops* and *Masyntes*), surface of fastigial dorsum passing regularly (sometimes quite narrowly) to sulcus of frontal costa; latter normal, sulcate, marginally carinate; supra-clypeal triangle pronounced to obsolete. Antennae quite short or of medium length, articles 12 to 14 in number, not enlarged distad, node on fourth from apex. Meso-metasternal cingulations marked. Subgenital plate of male ranging from entire, simple and poculiform (*Eumastax, Santanderia* and *Caenomastax*) to a rim-like sclerotized distal portion of variable depth with a membranous base[71] (*Masyntes, Temnomastax, Eumastacops, Paramastax* and *Pseudomastax*). Caudal femora lacking a proximo-dorsal overhang. Spines of internal extensor margin of caudal tibiae biseriate in length; caudal tibial spurs 2:2, flexor (second) ones small to very small, but always calcariform. Caudal metatarsi deplanate dorsad with lateral margins serrulato-carinate. Tarsal claws unequal. Margins of tibial spines unspecialized, of caudal tibial spurs unspecialized or finely serrulate, of tarsal claws finely serrulate.

Distribution.—Neotropical Region, from Cuba and Honduras to Bolivia and northern Argentina. Unknown from the Antilles other than Cuba.

Included genera:[72]

**Eumastacops* Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCIV, pp. 6, 55, (1942). Genotype (by original designation).—*E. caligo* Rehn and Rehn.

**Temnomastax* Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCIV, pp. 5, 9, (1942). Genotype (by original designation).—*Masyntes tigris* Burr.

**Masyntes* Karsch, Entom. Nachrichten, XV, pp. 26, 31, (1889). Genotype (by original designation).—*Mastax gundlachii* Scudder.

**Eumastax* Burr, Anales Soc. Españ. Hist. Nat., XXVIII, pp. 94, 257, (1899). [To replace *Mastax* Perty, 1830 (not of Fischer, 1825).] Genotype (by monotypy).—*Mastax tenuis* Perty.

**Santanderia* Hebard, Trans. Amer. Entom. Soc., XLIX, p. 184, (1923). Genotype (by original designation).—*S. lita* Hebard.

**Paramastax* Burr, Anales Soc. Españ. Hist. Nat., XXVIII, pp. 94, 268, (1899). Genotype (by original designation).—*Mastax nigra* Scudder.

**Caenomastax* Hebard, Trans. Amer. Entom. Soc., XLIX, p. 189, (1923). Genotype (by original designation).—*C. insignis* Hebard.

**Pseudomastax* C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 16, pp. 24, 25, (1914). Genotype (by original designation).—*Pseudomastax personata* (I. Bolívar) [=*Mastax personata* I. Bolívar].

Subfamily BIROELLINAE

1930. *Biroellinae* C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 46, pp. xxxi, 309.

The distinctive characters of the Biroellinae were discussed at length by C. Bolívar, who, however, was not aware that one of these features regarded by him as most striking and characteristic, i.e. the reduction of the caudal tibial spurs, is shared with two other subfamilies, both here diagnosed, (i.e. Morabinae and Euschmidtiinae), and that this reduction is carried to an even greater extreme in the Morabinae. Fundamentally, however, the basic relationship of the Biroellinae is closer to the Eruciinae than it is to the Morabinae, which in numerous respects is widely divergent from the other subfamilies of the Eumastacidae.

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[71] This condition is sometimes limited to the medio-proximal section alone.

[72] A key to the genera here listed was presented by Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCIV, pp. 4-7, (1942).

General features.—Form typically eumastacoid. Brevialate or (rarely) apterous. Fastigium short, moderately deflexed, surface of dorsum separated from sulcation of frontal costa by a low cingulato-arcuate bordering carinulation; frontal costa deeply sulcate with carinate lateral margins; supra-clypeal triangle distinctly outlined but low and transverse. Antennae not at all or but moderately surpassing length of cephalic femora, virtually filiform, composed of 18 articles, node on fourth from apex. Meso-metasternal cingulations relatively weak. Subgenital plate of male with two contrasted portions mesad, the more proximal fully sclerotized, the more distal membranous, the latter flanked by sclerotized supporting plates. Median femora of male inflated. Caudal femora lacking a proximo-dorsal overhang. Spines of internal extensor margin of caudal tibiae varying specifically in their arrangement in different length categories; caudal tibial spurs with flexor (second) always greatly reduced in size or external absent, the internal one, however, always calcariform, while the external is minute, straight and spiniform or absent. Caudal metatarsi excavate dorsad with margins at most but finely serrulate, except for a basi-external spine. Tarsal claws unequal. Margins of tibial spines, of caudal tibial spurs and of tarsal claws unspecialized.

Distribution.—New Guinea, the Aru Islands and Queensland, Australia.

Included genus:

**Biroella* I. Bolívar, Bol. Soc. Españ. Hist. Nat., II, p. 304, (1903). Genotype (by monotypy).—*B. dispar* I. Bolívar.

Subfamily ERUCIINAE

1903. *Eruciinae* Burr, Genera Insectorum, fam. Eumastacidae, pp. 2, 9.

This subdivision has had a rather checkered career, being first regarded as a "subtribe" (the Erucii) by Burr in 1899, but to include a much broader range of genera than here assigned; later in 1903 it was considered by Burr to be a subfamily, with the name here used for it, while it was similarly applied by C. Bolívar in 1930, but narrowed down in coverage to *Erucius* and *Mastacides*. In 1932, however, C. Bolívar reversed this conception and regarded the Eruciinae as inseparable from the Chorotypinae, with which he also merged the Erianthinae. From the present study the cancellation of the Eruciinae seems unwarranted and illogical.

General features.—Form typically eumastacoid. Alate to brevialate (in *Prionacantha*). Fastigium moderately (*Prionacantha*) or not at all

(*Erucius*) produced, its dorsal surface passing without break to the sulcation of frontal costa (as a narrow slit in *Prionacantha*), lateral borders of fastigium continuous with lateral margins of frontal costa, latter broad dorsad, distinctly constricted between paired ocelli, somewhat expanded between paired ocelli and median one, the lateral borders there labiately thickened and inflated, the median sulcus between the same narrowly incised, costa much less evident to subobsolete ventrad of median ocellus; supra-clypeal triangle present but not sharply defined. Antennae not surpassing cephalic femora in length, slightly flattened and widened distad, composed of 13 articles, node (in *Erucius*) on fourth from apex. Tegmina in fully alate forms membranous to suffused, wings in same membranous. Meso-metasternal cingulations subobsolete to obsolete (in *Erucius*), particularly cephalad. Subgenital plate of male divided in two mesad, nearly to base of plate in *Erucius*, lateral sections elongate and lobiform, interspace at base in *Erucius* filled with a subacuminate process. Caudal femora lacking a proximo-dorsal overhang. Spines of internal extensor margin of caudal tibiae biseriate in length, with a distal group of shorter category (*Erucius*), caudal tibial spurs normal, 2:2, margins serrulate. Caudal metatarsi sulcato-excavate dorsad, external margin with distal spine somewhat deflexed, margins serrulate or spined (*Erucius*); or merely a distal spine is present (*Prionacantha*). Tarsal claws unequal (in *Erucius*). Caudal tibial spines and spurs, metatarsal spines and tarsal claws marginally micro-serrulate in *Prionacantha*, in *Erucius* only tibial spurs and tarsal claws are marginally micro-serrulate.

Distribution.—Oriental and Indo-malayan regions; south India, Siam to Borneo and the Philippines.

Included genera:

* *Erucius* Stål, Bikang K. Svenska Akad. Handl., III (14), p. 36, (1875). Genotype (by original designation).—*Mastax agrionoides* Haan.

Prionacantha Henry, Trans. R. Entom. Soc. London, XC, p. 499, (1940). Genotype (by original designation).—*P. picta* Henry.[73]

Subfamily CHOROTYPINAE[74]

1876. *Choerotypidae* Stål, Ofvers. K. Vetensk.-Akad. Förhandl., XXX, no. 3, p. 54, footnote.
1889. *Erianthina* (group) Karsch, Entom. Nachr., XV, p. 25.
1893. *Choroetypi* Brunner, Ann. Mus. Civ. Stor. Nat. Genova, XXXIII, p. 114.
1899. *Erianthi* Burr, Anales Soc. Españ. Hist. Nat., Madrid, XXVIII, pp. 88, 103.
1903. *Choerotypinae* Burr, Genera Insectorum, Eumastac., pp. 2, 3.
1903. *Erianthinae* Burr, Genera Insectorum, Eumastac., pp. 2, 6.

The numerous changes in terminology, and the variety of opinions held as to the scope of this division, have been reviewed in the preceding historical analysis of the classification. Candido Bolívar's 1932 combining of the previously recognized Erianthinae with the Chorotypinae, while seeming quite drastic from a casual examination of some of the genera involved, is found warranted when a broader representation is considered. However, I am unable to include the genus *Erucius* in this subfamily, as he has done. It is quite possible that certain of the genera listed below, and which I have not examined, may prove to belong to the Chininae.

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[73] The position here given to *Prionacantha* is purely tentative, as I am unacquainted with the genus other than from the literature.

[74] The original spelling of the generic name from which this name was derived is *Chorotypus*.

General features.—Form generally compressed to a greater or lesser degree, in certain genera very strongly elevated and sublamellate dorsad, with procryptic mortuifoliaceous specialization. Fully alate in most genera, infrequently apterous (*Karnydia* and *Adrapetes*). Head with face deplanate, usually to a marked degree. Fastigium ranging from short and transversely truncate through transversely trigonal produced dorsad, to subcompressed rostrate dorso-cephalad, dorsal surface of fastigium completely separated from frontal costal sulcation; frontal costa basically chorotypoid, i.e. very broad and shallowly impressed dorsad, constricted at paired ocelli, scutellately expanded between these and median ocellus, then again constricted and thence obsolete or continued of varying width ventrad; supraclypeal triangle ranging from marked to obsolete. Antennae short, with 12-14 articles, node on antepenultimate one. Pronotum ranging from a generalized eumastacid type to an opposite extreme with it lamellately cristate dorsad and extended cephalad over head and caudad over a considerable portion of the alar organs. Tegmina (when present) ranging from hyaline (*Uvarovia*) to opaque and densely coriaceous, sometimes with distinct distal " caudate " lobations. Meso-metasternal cingulations ranging from pronounced to subobsolete cephalad of insertion of median coxae (*Erianthus* and *Burrinia*). Subgenital plate of male entire and cymbiform but provided with accessory lateral paired processes,[75] or divided mesad, usually to base, lateral parts of same elongate and lobiform, and interspace at base with an acuminate plate. Caudal femora with dorso-proximal overhang absent (*Erianthus*), slight (*Hemierianthus*) or well-developed (*Chorotypus*). Spines of internal extensor margin of caudal tibiae biseriate in length except for the distal group of 3-4 spines of varying ratio, all or part of series weakly to distinctly lamellately widened; caudal tibial spurs normal, 2:2; margins of internal caudal tibial spines and spurs may or may not be serrulate. Caudal metatarsi impresso- or sulcato-excavate, margins carinate, external spined, internal one serrate to unarmed, distal external spine may or may not be deflexed. Tarsal claws unequal, margins spined or unspined.

Distribution.—Indo-malayia and the Oriental Region from India and Ceylon eastward to and including Japan, Formosa, southern China, the Philippines and New Guinea; tropical West Africa from Assinie to the southern Belgian Congo.

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[75] These are called " terminal lobes " by C. Bolivar.

Included genera:[76]

Phyllochoreia Westwood, Mag. Nat. Hist., n.s., III, p. 495, (1839). Genotype (by monotypy).—*P. unicolor* Westwood.

**Chorotypus* Serville, Hist. Nat. Ins., Orth., p. 751, (1839). Genotype (by monotypy).—*C. fenestratus* Serville.

Scirtotypus Brunner, Abhandl. Senckenb. Natur. Gesellsch., XXIV, pp. 216, 220, (1898). Genotype (by monotypy).—*S. aberrans* Brunner.

**Orchetypus* Brunner, Abhandl. Senckenb. Natur. Gesellsch., XXIV, pp. 216, 220, (1898).[77] Genotype (by designation of Burr, 1899).—*O. rotundatus* Brunner.

**Hemierianthus* Saussure, Zool. Anzeiger, XXVI, p. 412, (1903).[78] Genotype (by original designation).—*H. gabonicus* Saussure.

Bennia Burr, Anales Soc. Españ. Hist. Nat., Madrid, XXVIII, pp. 94, 106, (1899).[79] Genotype (by monotypy).—*Mastax innotata* Walker.

**Erianthus* Stål, Bihang K. Svenska Vetensk.-Akad. Handl., III, no. 14, p. 36, (1875). Genotype (by original designation).—*Mastax agrionoides* Haan.

Butania I. Bolívar, Bol. Soc. Españ. Hist. Nat., III, p. 303, (1903). Genotype (by original designation).—*Bennia oberthuri* I. Bolívar.

**Burrinia* C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, núm. 46, pp. 83, 146, (1930). Genotype (by original designation).—*Bennia burri* C. Bolívar.

**Eupatrides* Brunner, Abhandl. Senckenb. Natur. Gesellsch., XXIV, pp. 225, 230, (1898).[80] Genotype (by designation of Burr, 1899).—*Acridium* (*Mastax*) *cyclopterum* Haan.

Karnydia C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, núm. 46, pp. 84, 160, (1930). Genotype (by original designation).—*K. celebesica* C. Bolívar.

Adrapetes Karsch, Entom. Nachr., XV, pp. 26, 28, (1889). Genotype (by monotypy).—*A. serraticrus* Karsch.

Uvarovia C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, núm. 46, pp. 84, 200, (1930). Genotype (by original designation).—*U. longipennis* C. Bolívar.

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[76] The sequence here given is essentially that utilised by C. Bolívar in 1930, with subsequent modifications made by him in 1932.

[77] C. Bolívar, 1932, placed *Kirbyita* C. Bolívar, 1916, as a synonym of *Orchetypus*.

[78] C. Bolívar, 1932, placed *Chescirtypus* C. Bolívar, 1930, as a synonym of *Hemierianthus*.

[79] C. Bolívar, 1932, placed *Ebneridia* C. Bolívar, 1930, as a synonym of *Bennia*.

[80] C. Bolívar, 1932, placed *Celebomastax* Willemse, 1931, as a synonym of *Eupatrides*.

Subfamily CHININAE

1899. *Chinae* Burr, Anales Soc. Españ. Hist. Nat., XXVIII, p. 256.
1903. *Chininae* Burr, Genera Insectorum, Eumastacidae, pp. 2, 14.

This division was originally considered the group Chinae by Burr in 1899, when it was erected to include the genus *China*, then described by him, and in 1903 he assigned it subfamily rank. In 1903 Burr associated the genus *Biroella* with *China* in this subfamily, but the latter was subsequently removed by C. Bolivar to the newly erected *Biroellinae*. The genus *Mnesicles*, however, is clearly a member of the Chininae, and not an erianthid as generally regarded.

General features.—Form typically eumastacoid, rather stout. Alate. Head somewhat broadened, face subdeplanate. Fastigium narrow, low, but slightly produced and weakly overhanging ventro-cephalad as seen in profile, dorsal surface of fastigium cut off from that of frontal costa by a low cingulate carina which borders the fastigial surface laterad and cephalad; frontal costa of eruciine type, i.e. relatively broad dorsad and then excavate within the sublamellate lateral margins, strongly constricted between the paired ocelli, broadening thence ventrad interantennally and with the lateral margins there labiately thickened and inflated, and with the median sulcation between a narrow incision, costa weak to subobsolete ventrad of the median ocellus; supra-clypeal triangle obsolete. Antennae very short, not surpassing cephalic femora, slightly widened to subclavate distad, with 12 articles, node on antepenultimate (*Mnesicles*) or preceding (*China*) one. Tegmina infumate or varied with color (*Mnesicles*). Meso-metasternal cingulations marked. Subgenital plate of male deeply divided in two, usually to base. Caudal femora with moderate but not decided dorso-proximal overhang. Spines of internal extensor margin of caudal tibiae not biseriate and increasing in length distad (*China*), or obsoletely biseriate with second to fourth from apex subequal in length and of minor category (*Mnesicles*), all sublamellately widened; caudal tibial spurs normal, 2:2, external pairs very much smaller than internal in *China*, margins micro-serrulate. Caudal metatarsi with dorsal surface impressed deplanate, lateral margins carinate and finely serrulate, external one with a single distal spine present and deflexed (*China*) or three or more spines present in distal half of same, the series deflexed distad (*Mnesicles*). Tarsal claws unequal (very strongly so in *China*), margins serrulate.

Distribution.—Oriental, Indo-malayan and Papuan regions, extending from Burma and Siam to southern China, and from the Mentawei Islands to the Philippines and New Guinea, although unreported from certain of the Greater Sunda Islands.

Included genera:

**China* Burr, Anales Soc. Españ. Hist. Nat., XXVIII, pp. 94, 256, (1899). Genotype (by monotypy).—*China mantispoides* (Walker) [=*Mastax mantispoides* Walker].

**Mnesicles* Stål, Öfv. Vet.-Akad. Förhandl., XXXIV (10), p. 54, (1877). Genotype (by monotypy).—*M. modestus* Stål.

Subfamily ESPAGNOLINAE new subfamily

1939. *Espagnolae* Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCI, pp. 169, 189.

This subfamily is clearly one of considerable antiquity and is more nearly related to the otherwise Old World Chorotypinae and Chininae than it is to any New World subfamily, although probably having closer relationship to the Episactinae than to any other known from the Western Hemisphere.[81]

General features.—Form (male alone known) compressed eumastacoid (suggesting *Erianthus* in this respect). Alate. Head very narrow, not transversely deplanate, areas between marked frontal costa and lateral facial carinae subexcavate. Fastigium rostrate produced, ascending, subuncinate in profile, apex narrowly rounded and obsoletely notched mesad, dorsum carinate; frontal costa strongly compressed between the ocellar groups, its lamellate borders there attingent, but diverging dorsad subfastigially, margins ventrad narrowly encircling median ocellus and costa of normal acridoid structure thence ventrad, excavato-sulcate mesad and carinate laterad; supra-clypeal triangle marked, broadly transverse truncate dorso-mesad. Antennae over 1.5 times as long as pronotum, slightly thickening distad, composed of 12 articles, node on distal one. Pronotum compressed, subexcavate dorsad, medio-longitudinally carinate. Tegmina (♂) subcoriaceous; wings largely membranous. Meso-metasternal cingulations subobsolete.[82] Subgenital plate of male consisting of a single arched sclerite, encompassing a broad membranous area meso-proximad. Caudal femora with no dorso-proximal overhang. Spines of internal extensor margin biseriate in length except that second to sixth from apex are subuniform and of the minor category also sublamellate; caudal tibial spurs normal, 2:2, margins micro-serrulate. Caudal metatarsi excavate dorsad, both margins carinate and spined throughout, distal spine not deflexed. Tarsal claws unequal in length, margins micro-serrulate.

Distribution.—The island of Hispaniola, West Indies.

Included genus:

**Espagnola* Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XLI, pp. 168, 169, 189, (1939). Genotype (by original designation).—*E. darlingtoni* Rehn and Rehn.

Subfamily EPISACTINAE

1899. *Episacti* Burr, Anales Soc. Españ. Hist. Nat., XXVIII, pp. 28, 253.
1903. *Episactinae* Burr, Genera Insectorum, Eumastacidae, pp. 2, 12.

When originally erected as a group this division contained solely two New World genera, i.e. *Episactus* and *Parepisactus*, to which in 1903 Saussure added the Malagasy genus *Malagassa*, which was subsequently placed in a subfamily of its own. In the same year, in the Genera Insectorum section on the family, Burr placed in this assemblage Bruner's genus *Gymnotettix*. A key to the genera of this subfamily as now understood was published by Rehn and Rehn in 1939.[88]

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[81] For comments on the relict character of the Espagnolinae, see Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XLI, pp. 189-192, (1939).

[82] The degree of development and the localization essentially as in *Erianthus*.

General features.—Form typically eumastacoid. Apterous. Fastigium but weakly produced, varying in degree and angulation, its dorsal surface separated from that of frontal costa by a transverse rounded angulation (*Gymnotettix*) or subcarination; frontal costa of usual type, sulcate and laterally carinate throughout, occasionally ampliate dorsad of paired ocelli, nowhere sharply constricted; supra-clypeal triangle pronounced, truncate dorso-mesad. Antennae shorter than cephalic femora, weakly thickened distad, composed of 8-12 articles, node on distal one. Meso-metasternal cingulations marked. Subgenital plate of male a single unit, entirely sclerotized, poculiform, free margin variously developed. Abdominal sternites three and four each with a medio-longitudinal callosity, stronger on the fourth. Spines of internal extensor margin of caudal tibiae biseriate in length, with spines two to sixth from apex uniform and of the minor category; caudal tibial spurs normal, 2:2, margins micro-serrulate. Caudal metatarsi excavate dorsad, with both margins carinate and strongly spined, distal spine not deflexed. Tarsal claws unequal in length, margins micro-serrulate.

Distribution.—Neotropical Region from southern Mexico to extreme southern Colombia, and the island of Hispaniola, West Indies.

Included genera:

**Episactus* Burr, Anales Soc. Españ. Hist. Nat., XXVIII, pp. 94, 254, (1899).[84] Genotype (by monotypy).—*E. brunneri* Burr.

Parepisactus Giglio-Tos, Bollett, Mus. Zool. Anat. Comp. Univ. Torino, XIII, no. 311, p. 36, (1898). Genotype (by monotypy).—*P. carinatus* Giglio-Tos.

**Antillacris* Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCI, pp. 197, 199, (1939). Genotype (by original designation).—*A. explicatrix* Rehn and Rehn.

**Lethus* Rehn and Rehn, Mem. Amer. Entom. Soc., no. 8, pp. 5, 37, (1934).[85] Genotype (by original designation).—*L. oresterus* Rehn and Rehn.

**Gymnotettix* Bruner, Biol. Cent.-Amer., Orth., II, pp. 20, 21, (1901).[86] Genotype (by monotypy).—*G. occidentalis* Bruner.

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[88] Proc. Acad. Nat. Sci. Phila., XCI, pp. 197-198.

[84] A key to the known species of *Episactus* is given by Rehn and Rehn, Mem. Amer. Entom. Soc., no. 8, pp. 24-25, (1934).

[85] A key to the known species of *Lethus* is given by Rehn and Rehn, Mem. Amer. Entom. Soc., no. 8, pp. 40-41, (1934). Synonym: *Mayamastax* Uvarov, Ann. Mag. Nat. Hist., (II) XI, p. 176, (1940). See Rehn and Rehn, Ent. News, LI, pp. 216-218, (1940).

[86] A key to the known species of *Gymnotettix* is given by Rehn and Rehn, Mem. Amer. Entom. Soc., no. 8, p. 10, (1934).

Remarks.—Rehn and Rehn have discussed the probable history of the Episactinae.[87] However, today I do not believe *Gymnotettix* indicates any direct relationship to the Eumastacinae (then called the group Eumastaces), as then suggested, and feel instead that genus exhibits what is perhaps " a reversion to type " in certain elements of its structure which are less characteristically episactoid, while others are essentially what we find in the here associated genera. Clearly *Gymnotettix* is less divergent from a generalized type, such as the Eruciinae, than are the other genera of the Episactinae.

Subfamily MALAGASSINAE

1945. *Malagassinae* Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCVII, p. 200.

The single genus on which this subfamily was erected had previously been associated with the otherwise New World Episactinae, a position given solely on account of its agreement in gross caudal metatarsal armament, and in spite of numerous features of difference, as pointed out by Rehn and Rehn when erecting the subfamily Malagassinae.

General features.—Form less compressed and more elongate fusiform than in most eumastacids. Apterous. Head pyramidical, transverse basioccipital margin with a distinct and broad obtuse-angulate median emargination. Fastigium produced, acuminately subspiniform, its apex minutely sulcate longitudinally, median line of occiput and fastigium shallowly carinate medio-longitudinally, dorsal surface of fastigium decurving laterad; frontal costa constricted in the area between the ocellar groups, the lateral margins being there attingent (♂) to subattingent (♀), dorsad of the paired ocelli the costa expands laterad (subfastigially) but the margins are subobsolete, while ventrad of the median ocellus the sulcation and bounding carinae are normal and moderately marked and continuous to the supraclypeal triangle, which latter is well marked and narrowly truncate mediodorsad. Antennae not exceeding the cephalic femora in length, but faintly broadened and subdepressed distad of fourth article, with 18 articles, node on antepenultimate one. Meso-metasternal cingulations marked. Subgenital plate of male entire, poculiform, simple. Spines of internal extensor margin of caudal tibiae strongly biseriate in length, second to fourth from apex uniform in length and of the minor category; caudal tibial spurs normal, 2:2, their margins micro-serrulate. Caudal metatarsi sulcato-excavate dorsad, lateral margins carinate, the external spined throughout, the internal only so distad. Tarsal claws nearly (caudal pairs) or quite equal in length, their internal margins briefly micro-serrulate mesad.

Distribution.—Madagascar.

Included genus:

* *Malagassa* Saussure, Rev. Suisse de Zoologie, XI, p. 88, (1903). Genotype (by monotypy).—*M. coniceps* Saussure.

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[87] Proc. Acad. Nat. Sci. Phila., XCI, p. 196, (1939).

Subfamily MIRACULINAE

1903. *Miraculinae* I. Bolívar, Bol. Soc. Españ. Hist. Nat., III, p. 307.

As I am unacquainted with this group from material, the features given below have been culled from the descriptions of I. Bolívar and Burr.

General features.—(Male only known.) Form moderately elongate. Apterous. Fastigium greatly produced, in proximal half a narrow shaft, distad developed into a transverse forked and sublunate extremity with acute latero-cephalic points, ventral surface of fastigium strongly carinate; frontal costa narrowly sulcate, constricted between the antennae and with its lateral margins there contiguous; supra-clypeal triangle marked. Antennae longer than cephalic femora, articles numbering 17-18,[88] individual articles subtriquetrous, node position ? Meso-metasternal cingulations ? Dorsal surface of abdomen medio-longitudinally carinate, third and sixth[89] tergites supplied with erect lobate appendages. Subgenital plate of male apparently entire, armed mesad with an " elongate, narrow, concave median lobe." Spines of internal extensor margin of caudal tibiae apparently in part at least biseriate in length, longer ones (at least) sublamellate; caudal tibial spurs ? Caudal metatarsus with external margin spinulose, internal margin ? Tarsal claws ?

Distribution.—Madagascar.

Included genus:

Miraculum I. Bolívar, Bol. Soc. Españ. Hist. Nat., III, p. 306, (1903). Genotype (by monotypy).—*M. mirificum* I. Bolívar.

Subfamily THERICLEINAE

1899. *Thericleis* Burr, Anales Soc. Españ. Hist. Nat., XXVIII, pp. 91, 278.
1903. *Thericleinae* Burr, Genera Insectorum, Eumastac., pp. 2, 17.
1914. *Plagiotripti* C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 16, p. 40.

Although the assemblage centering about the genus *Plagiotriptus* has been separated from the more typical members of the Thericleinae, and the study of more genera than are at present available may show that the two entities have at least tribal value, at this time it seems most advisable to follow C. Bolívar's 1930 conclusions,[90] and regard all the genera previously placed in these divisions, except those now known or believed to belong to the here-erected Euschmidtiinae, as members of the Thericleinae.

General features.—Form compressed to a greater or less degree. Apterous to brevialate (in *Piezomastax*). Head with face deplanate to a greater or lesser degree. Fastigium narrow, lateral margins carinate to sublamellate, dorsal surface passing usually narrowly to sulcation of frontal costa, with or without the presence of a transverse carinula; frontal costa well marked but usually strongly compressed, particularly dorsad, median sulcation generally a fissate slit, bordering carinae uniformly continued ventrad; supra-clypeal triangle absent. Antennae with 9 (in figures of *Urrutia*) to 12 (in figures of *Pieltainidia*) articles, variable in length, occasionally thickened distad, node on penultimate or antepenultimate article (in genera examined). Meso-metasternal cingulations marked. Subgenital plate of male simple, fully sclerotized, compressed or subbulbous. Caudal femora with distinct dorso-proximal overhang. Spines of internal extensor margin of caudal tibiae regularly decreasing in length proximad and distad; caudal tibial spurs normal, 2:2. Caudal metatarsi sulcato-excavate dorsad, lateral margins carinate and unarmed except for a single disto-external spine. Tarsal claws equal (*Pseudothericles*) to unequal in length.

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[88] Burr (Genera Insectorum, Eumastacidae, pl. fig. 10a, b and c) gives three drawings made by I. Bolívar from the unique type of *Miraculum*. In figure 10b, which is a cephalic view of the head, I am able to count 17 articles in one antenna and 18 in the other. The exact number is not given in Bolívar's description.

[89] From the evidence of Burr's figure 10c this would appear to be the seventh tergite, but the original description states " sixth."

[90] Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 46, p. xxxii, footnote 1.

Distribution.—Tropical and Southern Africa and Arabia.

Included genera:[91]

**Plagiotriptus* Karsch, Entom. Nachr., XV, p. 8, (1889). Genotype (by original designation.)—*P. hippiscus* (Gerstaecker).

**Piezomastax* C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 16, p. 42, (1914). Genotype (by original designation).—*P. carli* C. Bolívar.

Manowia C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 16, p. 45 (1914). Genotype (by original designation).—*M. alca* C. Bolívar.

**Brachytypus* Burr, Genera Insectorum, Eumastac., pp. 3, 5, (1903). Genotype (by selection of Kirby, 1910[92]).—*Plagiotriptus rotundifrons* Burr.

Phaulotypus Burr, Bull. Liverpool Mus., II, no. 2, p. 44, (1899). Genotype (by monotypy).—*P. granti* Burr.

Clerithes C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 16, p. 36, (1914). Genotype (by original designation).—*C. tanganikensis* C. Bolívar.

Urrutia Ramme, Eos, I, p. 201, (1925). Genotype (by monotypy).—*U. somalica* Ramme.

Schulthessiella C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 16, p. 34, (1914). Genotype (by original designation).—*Parathericles minutus* Schulthess.

Pieltainidia Ramme, Eos, I, p. 199, (1925). Genotype (by monotypy).—*P. mira* Ramme.

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[91] The serial arrangement of these genera is not to be considered as an expression of any final conclusions as to their linear disposition.

[92] Synon. Catal. Orth., III, p. 69, (1910).

Thericlella C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 16, p. 32, (1914). Genotype (by original designation).—*T. nigromaculata* C. Bolívar.

Parathericles Burr, Anales Soc. Españ. Hist. Nat., XXVIII, pp. 95, 293, (1899). Genotype (by monotypy).—*P. elephantulus* Burr.

Bunkeya C. Bolívar, Trab. Mus. Nac. Cienc. Nat., Madrid, Ser. Zool., núm. 16, p. 27, (1914). Genotype (by original designation).—*B. congoensis* C. Bolívar.

**Pseudothericles* Burr, Anales Soc. Españ. Hist. Nat., XXVIII, pp. 95, 282, (1899). Genotype (by original designation).—*Thericles compressifrons* Stål.

**Thericles* Stål, Bihang K. Svenska Vetensk.-Akad. Handl., III, no. 14, p. 35, (1875). Genotype (by selection of Burr, 1899[93]).—*T. obtusifrons* Stål.

Remarks.—As I have examined less than half the genera here placed in this subfamily, those of which I have been unable to examine material must be regarded as tentatively assigned. To the same degree the features given above for this subfamily may require reconsideration, when more of the genera not now available have been compared with those from which these characters have been drawn.

Subfamily EUSCHMIDTIINAE new subfamily

How cohesive this assemblage is remains to be determined when a larger proportion of the genera here allocated have been physically compared. A number of the genera are as yet known only from the unique type material. In most cases the literature is deficient in its description of characters which we now know to be of marked importance, and others here used for the first time are, of course, unmentioned.

For the genera which I have been able to examine the subfamily has a relative cohesiveness, and by the same premises it is a peripheral entity in the family. Whether the other genera here assigned, material of which has not been examined, will fully support this conclusion remains for the future to determine.

General features.—Form essentially eumastacoid, slender, often fusiform, usually not compressed (weak in *Cymatopsygma*) nor ampliate dorsad. Apterous to fully alate (*Cymatopsygma*). Head rarely subconical (in *Amatonga*). Fastigium ranging from briefly rostrate-produced (as in *Amatonga* and *Cymatopsygma*) to non-projecting (*Euschmidtia*), lateral borders usually strongly carinate to sublamellate, surface passing (often as a narrow slit) to frontal costa sulcation; frontal costa of usual type; supra-clypeal triangle not evident. Antennae of variable, but never marked, length, composed of 15-16 articles, node on penultimate, antepenultimate or preceding article.[94] Meso-metasternal cingulations marked. Subgenital plate of male ranging from entire and rostrate (*Euschmidtia*), through a type with membranous base and distal transverse sclerotized section with processes (*Amatonga*), to one with three subparallel proximally connected plates with immediate base membranous (*Carcinomastax* and *Amalomastax*). Spines of internal extensor margin of caudal tibiae not markedly biseriate in length, as a whole decreasing in length proximad and distad; both external caudal tibial spurs present and normal, while flexor internal one is greatly reduced (*Euschmidtia*), minute and spiniform (*Carcinomastax*), or absent (*Amatonga* and *Amalomastax*). Caudal metatarsi sulcato-excavate dorsad, lateral margins carinate and unspined except for deflexed external distal spine (present in certain genera). Tarsal claws unequal, margins simple.

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[93] Anales Soc. Españ. Hist. Nat., XXVIII, p. 298, (1899).

Distribution.—Tropical and Southern Africa, Madagascar, Comoros and Seychelles.

Included genera:[95]

**Penichrotes* Karsch, Entom. Nachr., XV, pp. 26, 32, (1889). Genotype (by monotypy).—*P. nudata* Karsch.

**Carcinomastax* Rehn and Rehn, Proc. Acad. Nat. Sci., Phila., XCVII, p. 221, (1945). Genotype (by original designation).—*C. portentosa* Rehn and Rehn.

**Amatonga* Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCVII, p. 216, (1945). Genotype (by original designation).—*A. spicata* Rehn and Rehn.

**Euschmidtia* Karsch, Entom. Nachr., XV, pp. 27, 35, (1889). Genotype (by monotypy).—*E. sansibarica* Karsch.

**Amalomastax* Rehn and Rehn, Proc. Acad. Nat. Sci. Phila., XCVII, p. 240, (1945). Genotype (by original designation).—*A. lambertoni* Rehn and Rehn.

Cymatopsygma Karsch, Stett. Entom. Zeit., LVII, p. 247, (1896). Genotype (by monotypy).—*C. flabelliferum* Karsch.

Peoedes Karsch, Entom. Nachr., XV, pp. 27, 34, (1899). Genotype (by monotypy).—*P. appendiculatus* Karsch.

Macromastax Karsch, Entom. Nachr., XV, pp. 27, 34, (1899). Genotype (by monotypy).—*M. infernalis* Karsch.

Symbellia Burr, Anales Soc. Españ. Hist. Nat., XXVIII, pp. 95, 286, (1899). Genotype (by selection of Kirby, 1910[96]).—*S. karschi* Burr.

Apteropeoedes I. Bolívar, Bol. Soc. Españ. Hist. Nat., III, p. 305, (1903). Genotype (by monotypy).—*A. nigroplagiatus* I. Bolívar.

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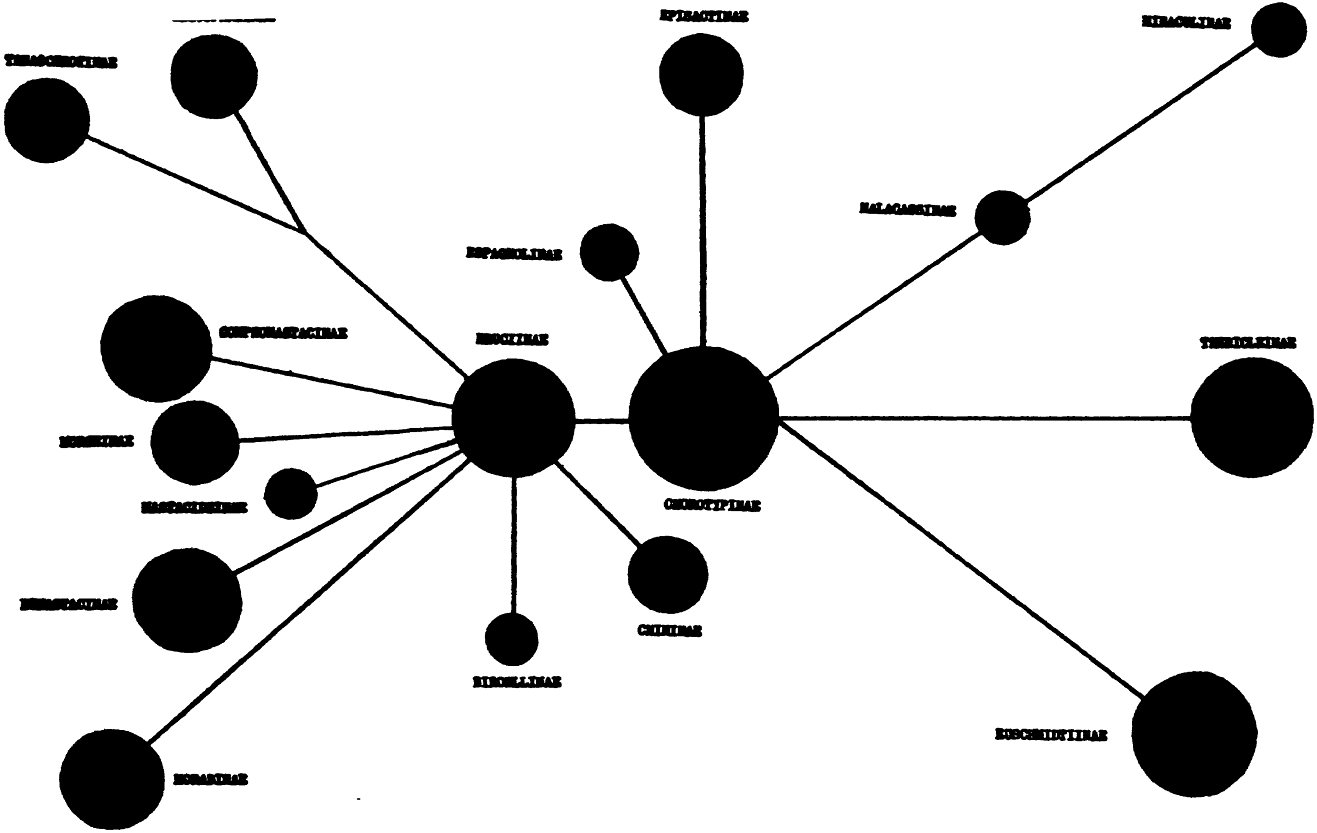
[94] The information on the nodal position has been drawn solely from the genera of which I have examined material.

[95] The listing of the genera is not to be considered an expression of linear arrangement, as many of them are not available for study.

[96] Synon. Catal. Orth., III, p. 81, (1910).



Phylogenetic arrangement of the subfamilies of the Eumastacidae as here presented.

Bionomics and Life Histories

In 1930 Candido Bolívar was able to assemble, from previously published work, observations on these aspects of the family for but six genera, while today available published information and unpublished personal observations bear upon seventeen genera, and in some cases more than a single species of a genus.

The first observation published on the habits or actions of eumastacids was that of Alluaud[97] in 1895 on *Pcoedes cruciformis* of the Seychelles, which he said frequented the foliage of trees and in repose placed its caudal femora perpendicular to the body in the form of a cross, hence the specific name. Approximately the same general pose is now known to be common to a number of eumastacid genera. Kershaw, in 1913, presented[98] an interesting series of observations made near Macao, South China, on what he called a species "of Mastax or Eumastax," but which his figure shows to be an *Erianthus*, considered by Candido Bolívar to be *E. versicolor dohrni*. The species was found only in wooded districts and appeared to feed entirely on shrubs and woody plants, with a favorite food plant *Paretta indica* (Rubiaceae). Eggs were laid on September 14, deposited in small batches in the ground in the usual manner but with little protection. One pair of the insects remained in copula about three hours in the early morning and the eggs were laid in the afternoon. The first nymphs hatched the morning of April 8. His summary of the life history of the species is as follows: Eggs laid, September 14, 1906; eggs hatched, April 8, 1907; first moult, May 26, 1907; second moult, June 6, 1907; third moult, June 21; fourth moult, July 5; fifth moult, July 24; sixth moult to adult, August 20, 1907. By early November all had died off. The females appeared to live about a month longer than the males. The weather from November to March was really cold and this also is the dry season. There was but one brood a year. After the final moult the male took about five days to arrive at full adult coloring for that sex, passing through various brown and ochreous colorings before the green tints gradually became visible. Kershaw stated the species never increased noticeably in any season and individuals were slow breeders, with their eggs probably often destroyed. In view of the steady and sustained destruction of woodland in that part of China he felt the species was probably rapidly diminishing in numbers, and doubtless was being replaced by other forms of Acridoidea better adapted to altered conditions of life.

In 1918 Rehn and Hebard presented[99] the first set of observations to be made on any New World eumastacids. These relate to the genera *Morsea* and *Psychomastax,* but chiefly the former. They show that both genera are thamnophilous, with a particular liking for perching on the tops of various species of bushes, spiny or otherwise, in the chaparral of mountain slopes in portions of the southwestern United States. The bushes in which *Morsea* (*M. c. californica* and *M. c. tamalpaisensis*) were particularly noted in California were chamise (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos tomentosa*) and Nuttall's Ceonothus (*Ceonothus cuneatus*). The genus *Morsea* was taken in California as high as 5600 feet, and at the lower level of its range, which was little above sea-level, it also occurred on *Eriogonum polifolium.* In Nevada *Morsea californica dumicola* was encountered as high as 6000 feet, and found on antelope brush (*Purshia tridentata*), the latter sometimes growing among open stands of Utah junipers (*Juniperus utahensis*) and pinyon (*Pinus monophylla*). Adults of *Morsea* were secured at various localities on dates ranging from mid-July to late September. These authors give the following word-picture of the actions of individuals of these genera in the chaparral: "You will, by careful scrutiny, find them with short antennae erect and parallel, caudal limbs akimbo, the whole insect picturing alertness and vigor. Their ability to jump is developed in full proportion to their very long and lever-like caudal limbs, as a single bound will often place them in a place of safety on a chamisal bush well out of reach, except by a new and cautious advance through the heavy brush, often with similar disappointing results."

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[97] In I. Bolívar, Ann. Soc. Entom. France, LXIV, p. 377, footnote 1.

[98] Journ. Bombay Nat. Hist. Soc., XXII, pp. 416-417, lower figures of plate B.

[99] Trans. Amer. Entom. Soc., XLIX, pp. 224-225, 233-234, 238, 241, 247.

Amplifying the 1918 observations, Hebard in 1934 presented[100] a much more extensive set of observations on the habits of the three races of *Psychomastax psylla,* these made during the numerous seasons spent in the southwestern United States in field work with the present author. His general summary is in part as follows: "Like those of *Morsea,* the races of *Psychomastax* are thamnophilous but often are found on the ground among the bushes in which they live. Such bushes are the chamisal (very characteristic of the chaparral of the hills and mountains of southern California), wild gooseberry, antelope brush (*Purshia tridentata*) and mountain mahogany. The insects apparently often seek shelter also in the junipers when found where these small trees grow. These diminutive insects usually rest with caudal limbs much more divergent from the body than is usual in grasshoppers, their leaps suggesting the use of these members as a cross-bow with their body the arrow. Though their leaps may be extremely quick, the impression is often given that they rely to some extent on immobility, often pausing and when motionless being remarkably protected both by coloration and form." Hebard noted that *Psychomastax p. psylla* was taken from

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[100] Trans. Amer. Entom. Soc., LIX, p. 364, (1934).

Purshia in the zone of juniper and pinyon, and was also found about patches of a low gray-green leaved spiny bush in forests of sugar pine (*Pinus lambertiana*), incense cedar (*Libocedrum decurrens*) and Douglas fir (*Pseudotsuga mucronata*). He also gave a variety of habitats for *Psychomastax psylla robusta,* such as in juniper, wild gooseberry (*Grossularia* sp.), on the ground among wild gooseberry under bristle-cone pines (*Pinus aristata*) at 11,500 feet elevation, in sage brush (*Artemisia*), on bare decomposed granite gravel and on granite boulders among fox-tail pines (*Pinus balfouriana*), and on almost bare slopes between bushes of mountain mahogany (*Cercocarpus ledifolius*) under western yellow pine and juniper and pinyon. The desert subspecies of *P. psylla* (i.e. *deserticola*) was noted by him as very numerous in the few chamise bushes (*Adenostoma*) at the type locality (Cushenberry Ranch, California). Hebard also noted in 1935, in the original description of *Eumorsea balli,*[101] that this little-known genus was taken in Arizona on Mexican pinyon (*Pinus cembroides*).

In 1920 Ramachandra Rao reported [102] that in several areas of southern India a species of *Mastacides* (which C. Bolívar in 1930 described as *M. ramachandrai*) attacked the flowers and leaves of *Lantana,* as well as other plants. Like most other observers he mentions the characteristic eumastacid pose.

Burr in a set of field letters from Angola and other areas of south-central Africa, which were published in the Entomologist's Record between 1927 and 1930, noted *Penichrotes* as swept in open country in Angola, and *Thericles* similarly secured from grass in sparse woodland in the same colony. His most extensive observations were made in Northern Rhodesia, where he reported *Thericles* as numerous in low scrub and also sitting on bushes and shrubs in the undergrowth of the forest. He states regarding the usual position of certain unnamed eumastacids which he encountered, " that they keep their hind legs not in a vertical plane, as does *Thericles,* but in a horizontal plane at right angles to the body, akimbo so to speak." He also notes that *Thericles* jumps more vertically than the other forms, and also that a species of that genus in Northern Rhodesia, different from the one taken in low herbage in Angola, was found sitting on leaves of the mopane tree (*Copaifera mopane*) at a height of from five to six feet from the ground. Relative to an unnamed species of eumastacid found in the Luano Valley of Northern Rhodesia, he presents [103] the following important observations: " I have noticed the nymphs about in the bush and that they have a preference for exalted situations; I often see them sitting high on my tent ropes or on my towels drying on a tree, but for a long time came across only isolated specimens. . . . But one evening I found them. In the neighborhood of the camp are a number of stumps of mopane that have been felled for timber and on these I found a number of these curious little grasshoppers, adult about the end of February. They sit on the leaves and on the stems of the leaves; in the latter position they are well hidden, as the dark back, with short elytra, harmonises with the twig and the bright green long hind femora, always at right angles to the body, have the air of stems of leaves. They are extremely active and when disturbed or on the approach of an enemy, they leap like an arrow out of a bow; I have never seen one open its somewhat abbreviated wings, and they fall to the ground, but an adult will clear a distance of two and a half yards with ease. . . . In the nymph, the scales of the future elytra may be dark or green but I have not seen an adult with anything but dark elytra; another curious point is that in the nymph, in which green is the predominating colour, though often varied with blackish, the face is almost invariably black, and this black remains prominent on the empty cast skin, but I have not seen an adult with a dark face."

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[101] Trans. Amer. Entom. Soc., LXI, p. 119.

[102] Mem. Dept. Agric. India, Entom. Series, V, no. 6, pp. 294-295.

[103] Entom. Record, 1930, p. 86.

In 1930 Candido Bolívar [104] quotes apparently unpublished observations of Escalera, who noted *Hemierianthus camerunensis* on Fernando Pó living on the leaves of bushes, and remarked the rapidity with which it darts into flight when capture is attempted. Hingston, in 1932, in a series of observations on protective devices of tropical insects, said regarding an immature eumastacid in British Guiana [105] which assumed the characteristic "cross" position of so many members of the family, "its body made one stem and its femora another. The result was that it looked like two green stems resting one across the other." He further notes, "another with exactly the same habits frequented the forest-floor. It was brown like withered foliage and when it assumed the cross-like attitude it looked as if it were two dead bits of stick lying on the leaf carpet."

Observations on the habits and actions of individuals of the genera *Gymnotettix*, *Episactus*, *Lethus* and *Eumastax* were recorded by Rehn and Rehn in 1934,[106] these drawn from field observations of the senior author. They noted that *Gymnotettix lithocolletus* was found in the semi-arid valley of the Rio Choluteca of Honduras, living in rich bush vegetation with savannah-like clumps of trees of acacia type, low mimosas and occasional cacti, all often tangled with climbing vines, and frequenting low often weedy cover reaching not over five feet above the ground. In Costa Rica *Episactus tristani* was taken from roadside weeds and low cover in coffee groves, and also on undergrowth foliage in mountain cloud-forest with many tree-ferns and bromeliads. The Honduranian *Lethus oresterus* was found to be partial to the drier sections of subtropical cloud-forest, particularly near the forest border, and " always on the ground," usually on or near dead leaves, but more rarely " in areas of short grass and other low cover," while very rarely it was noted on bare rock outcrops. Both sexes of *Lethus* were noted as good jumpers, but the females were more active and more numerous than the males, and the former sex was markedly protected by its dull uniform coloration, while the male is conspicuously bicolored. Rehn and Rehn's notes on five Central American species of Eumastax (*kressi, surda, dentata, silvicola* and *hondurensis*) show that certain of them live on the foliage of the ground cover in heavy lowland rain-forest, particularly preferring " the patches of sunlight which filter through the heavy leaf canopy overhead and spangle the forest shade with pockets of brilliancy." In referring to *E. kressi* they also comment on something which is characteristic of these and other rain-forest undergrowth locusts, i.e. " as soon as the sunlight failed, or the frequent rainy season showers descended, it was not to be seen." The species *surda,* of the Pacific side of Costa Rica, was found in somewhat more open forest than *kressi* and *silvicola* of the Caribbean slope of the same country.

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[104] Trab. Mus. Nac. Ciencias Naturales, Madrid, Ser. Zool., núm. 46, p. XXVIII.

[105] "A Naturalist in the Guiana Forest." By R. W. G. Hingston. Pages 251-252, fig. 103b.

[106] Mem. Amer. Entom. Soc., no. 8, pp. 20 (*Gymnotettix*), 32 (*Episactus*), 53 (*Lethus*), 63 (*Eumastax kressi*), 68 (*E. surda*), 72 (*E. dentata*), 75 (*E. silvicola*), and 79 (*E. hondurensis*).

In 1937 Chang recorded[107] *China mantispoides,* at Ihing, Kiangsu Province, China, as frequenting the trunks of pine trees (which he presumed were *Pinus massoniana*), in which situation they were distinctly protected by their coloration, while he also noted that individuals of *Pielomastax octavii* were found in the Kuling Mountains of Kiangsi Province, China, among grass up to two feet high, were sluggish in action and did not jump far.

Individuals of *Teicophrys strigilecula* were recorded by Rehn and Rehn,[108] on the basis of observations made at Oaxaca, Mexico, by the collector Dr. H. R. Roberts, as occurring " in open pasture country with scattered low acacia-like thorn bushes and weeds in dry grassy hillsides."

In 1944 Henry published a very interesting set of observations on a female individual of *Orchetypus rugifrons,* which was taken at Labugama, in the Western Province of Ceylon.[109] These comments are here in large part quoted. The species " is highly pro-cryptic in form and colour, resembling a shrivelled dead leaf with amazing exactness. This dead-leaf resemblance might lead one to suppose its natural habitat to be among the litter of dead leaves on the forest floor, but this is not so; it lives among leaves of bushes from 3 to 6 feet above the ground." He further notes that he also had once taken the species on a bare tree trunk well above the level of herbage at the base of the tree, and that its dead-leaf color-scheme is not necessarily revealing among green foliage, " for every bush in a tropical forest has dead, or partly-dead, leaves plentifully distributed among the living ones." He points out that aside from the compressed body form, the dead-leaf appearance " is accentuated by the insect's habit of keeping the hind femora—which are also compressed and flattened—closely pressed to the side, which they are curved to fit, giving the impression of a single plane surface. The abdomen is usually curled up so that the median groove in its supra-anal plate receives the lower edges of the tegminal apices. The dorsal margin of the tegmina fits against the ventral margin of the backwardly produced pronotum. The curling-up of the abdomen produces a nearly circular hiatus between its dorsum and the costal margin of the tegmina and this suggests a hole in the dead leaf, which hole is given an appropriately ragged appearance by a triangular lobe on the hind tibia which partly covers it in normal resting attitude. The tips of the wings project beyond the tegmina as narrow processes which curl outwards. When under the influence of ' fear ' or ' apprehension ' the insect . . . curls the abdomen more tightly, at the same time twisting it in such a way that the apex inclines toward the object of fear." Henry concludes that " whatever the physiological explanation of this strange attitude may be there is no doubt that it increases the resemblance to a leaf by creating an appearance of asymmetry, unexpected in an animal but quite appropriate in a dead leaf."

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[107] Notes d'Entom. Chin., IV, fasc. 40, pp. 37-46.

[108] Proc. Acad. Nat. Sci. Phila., XCI, p. 184, (1939).

[109] Ceylon Journ. Sci., B (Zoology), XXII, pt. 2, pp. 193-195, fig. 1.

In walking, " *Orchetypus* proceeds in a series of jerks, its body continually swaying from side to side and jerking forwards and backwards. Frequently the insect quivers, exactly as if blown by the wind. It was repeatedly noticed that it seldom or never made a move unless a puff of wind was stirring the surrounding leaves; in still air it would remain comparatively quiescent but at every gust of wind it commenced to quiver and would sometimes run quite rapidly for several inches while the leaves were in motion. If seriously alarmed it leaps with great speed and power." This specimen fed on leaves of *Hibiscus, Acalypha* and *Syzygium,* taking " 3, 4 or 5 large bites from the edge of the leaf and then masticating slowly, as if performing a solemn rite, for a few minutes before taking more bites. The head displayed a surprising power of mobility and protrusibility when feeding, though in resting attitude it is retracted into the pronotum." The antennae, as is usual in many eumastacids, were said to be "normally directed straight upwards." This specimen laid one mass of 41 or 42 eggs, none of which hatched. "They were merely dropped from the insect's position on a leaf onto the surface of the soil in a pan in the cage." Henry considered the laying to be "probably quite abnormal." . . . . The eggs measured 5.7 × 1.1 mm.," while their surface "was finely shagreened with a network suggestive of a microscopic mosquito-netting stretched over them tightly."

Tinkham in 1947[110] and Rehn in 1948[111] published extensive notes on the occurrence, actions, and plant associations of the genus *Tanaocerus*, and also called attention to its unusual seasonal occurrence, i.e. that it occurs adult, in a temperate region, as early as December 27, but no mature individuals have been taken in summer, although it doubtless occurs adult later than mid-April, the latest date represented by such material. During the summer months—the period of maximum heat over the range of the genus—individuals are all immature. However, Rehn shows that while representative of low and exceedingly hot desert areas, when it is found in a variety of such environments, the genus occurs in California as high as 8200 feet. While adults (and particularly the females), as shown by Rehn, are more definitely terrestrial, the immature individuals were noted by Tinkham as occurring on *Franseria dumosa, Hymenoclea salsola* and *Coleogyne ramosissima*, to which Rehn has added the creosote bush (*Larrea divaricata*), desert holly (*Atriplex hymenelytra*) and brittle bush (*Encelia farinosa*). The observations on adult individuals of *Tanaocerus*, by Roberts, who has had the most extensive experience of any one with this little-known genus, and whose notes were quoted by Rehn, show that when disturbed, adults of *Tanaocerus* "will try and hide among the stones," these sometimes small shaly pebbles, at other places they were on fine gravel or coarse sand. When disturbed on the ground adults sometimes leaped to the adjacent bushes. Individuals placed in cages "seemed very sluggish during the day in the sun," but toward sunset (April 12), when it was much cooler, they were much more active. The immature condition, as pointed out by Tinkham, is exceedingly active.

I am able to add a few notes on certain genera drawn chiefly from unpublished personal observations. In 1931 in the dry season in interior Matto Grosso, Brazil (at Descalvados and near Santa Rosa), I found immature individuals of a species of *Temnomastax* in low cover along a road border, and also in ground cover in open leafless dry forest. In June, 1934, along the Athi River about sixteen miles northeast of Kibwezi, Kenya, I found *Thericles* on twig-littered dry ground in open dry forest, and at the same time and place immature individuals of the protectively formed *Plagiotriptus* were swept from a low bush with green leaves. My old friend the late Dr. Wilfred H. Osgood, former Emeritus Curator of Zoology at the Chicago Museum of Natural History, some years ago told me of a personal experience with an unknown locust in the rain-forest country of eastern Peru. He was collecting mammals at the time and noticed that frequently he would flush this insect from the forest undergrowth, that it would spring from the foliage and by suddenly spreading its wings would give the appearance of bursting pop-corn, as the hind wings were pure white, and this color would, of course, instantly disappear when it alighted. He caught several to make sure what sort of insect it was, and found it to be an acridid. When he related the story to me, I put before him a spread specimen of *Paramastax nigra*, the only locust known to me with white hind wings, and he said at once it was the species he had observed.

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[110] Amer. Midl. Nat., XXXVIII, pp. 143-145.

[111] Proc. Acad. Nat. Sci. Phila., C, pp. 5-7.

Possible Adaptive Value of Certain Structures

In the preceding summaries of important morphological features, and of our knowledge of eumastacid life histories and habits, attention has been drawn to certain structures, and to actions and habits which may be correlated with the same. A few of these rather unusual types of development and habits seem worthy of special mention, in view of their possible interdependence.

In virtually all of the thamnophilous eumastacids with which I have had acquaintance in life, the antennae are always carried erect and nearly or quite parallel to one another. The same is true, but to a less marked degree, of the species which I have found on the leaves of undergrowth in lowland tropical rain-forests in Central and South America. In no other group of locusts is this tendency so strongly and so generally developed. We know nothing as yet of the histology or possible function of the nodose structure found distad on the ventral surface of the antennae in the Eumastacidae, and to which attention has been drawn on a preceding page, but as this surface (the ventral) is carried facing cephalad in the usual antennal position, this specialized structure is very probably sensory, and doubtless serves a special function in the insect's economy.

As I have already mentioned under the section on " meso-metasterna " in the preceding discussion of various morphological features, in certain genera the deplanation of this surface is on two slightly different planes, i.e. that of the portion caudad to the cephalic border of the mesosternal interspace is slightly ascending dorso-cephalad, while the metasternal section and the mesosternal lobes are more truly horizontal, the line of demarcation being an appreciable but not decided surface angulation. This condition is strongly developed in the genus *Lethus*, which is geophilous and terrestrial, and it is possible this marked biplanation of the greater portion of the ventral surface serves a definite function in connection with landing upon and launching from a ground surface. As far as I have observed similar surface developments do not occur in genera which are known to be entirely thamnophilous.

One correlation of structure and actions, however, seems clearly evident in the Eumastacidae. This is the association of caudal femora lacking a dorso-proximal overhang, with the ability to rotate the caudal limbs laterad in the characteristic cross-bow fashion found in many eumastacids. Those genera in which a dorso-proximal overhang is distinctly developed do not seem to possess this ability, at least from my personal observations of them in life, and nothing which has appeared in print leads one to believe otherwise.

Henry [112] has called attention to the rotation of the caudal tarsi at the tibio-tarsal articulation noticed by him in the genus *Prionacantha*, a condition which he also notes as occurring in other eumastacids. This ability is very probably of added usefulness in furnishing a solid and satisfactory stance for the " cross-bow " type of jumping, which is habitual with many members of the family, particularly those of thamnophilous or forest foliage-frequenting habits. The forms possessing a pronounced dorso-proximal overhang on the caudal femora apparently lack the ability to throw the caudal limbs into the cruciform position, and these forms as a whole are less thamnophilous or foliage-frequenting than those lacking the proximal caudal femoral overhang. It is my belief that future studies will show that those forms possessing the overhang, and which in jumping keep their caudal limbs closely placed to, and subparallel with, the body are capable of jumping to a greater height, or at least more directly vertical, than is true of the far greater number of forms which lack the dorso-proximal caudal femoral overhang. This latter assemblage, by virtue of the action of their catapulting caudal limbs, can throw their bodies bolt-like to a great distance directly forward, and in so doing lift but little from the horizontal plane. In those forms possessing this ability the objective apparently is to seek safety by reaching another shrub, in semi-arid environments, or a different patch of undergrowth foliage, in lowland tropical forest. In the case of terrestrial or ground-cover frequenting forms the effort seems to be to seek shelter at a higher level, at least temporarily, until a potential hazard has been averted.

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[112] Trans. R. Entom. Soc. London, 90, p. 501, (1940).

Position of Family in the Acridoidea

The position of the Eumastacidae in the acridoidean system suggested by Roberts,[113] i.e. as a family more closely related to the Proscopiidae than to any other major division, with a less intimate relationship to the Tetrigidae, and even more widely distinct from the Acrididae, is fully supported by the present study. As already stated in the preceding resumé of its known geological history, the Eumastacidae are probably as old as, if not older than, the Acrididae, when their emergence from purely fossil ancestral stocks is considered. Whether their antiquity is as great as, or greater than, that of some of the other families of the superfamily cannot be determined from present knowledge, as fossil evidence is not available.

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[113] Proc. Acad. Nat. Sci. Phila., XCIII, p. 232, (1941).

FISHES OF THE NUELTIN LAKE EXPEDITION, KEEWATIN, 1947.
PART 1—TAXONOMY

BY HENRY W. FOWLER

Curator of Fishes, The Academy of Natural Sciences of Philadelphia

The collection of fishes brought back by Dr. Francis Harper from Keewatin and Manitoba, Canada, is perhaps most valuable from the point of view of distribution. It also affords an interesting sketch of the ichthyology of the western Hudson Bay region of Keewatin and Manitoba. Very few fishes have ever been reported from there, and none, so far, with such detailed data as he has gathered. In his report (Part 2, of the present paper) original notes and observations, and references to the literature may be found.

The specimens number about 100 and are referable to 13 species or subspecies. Three are described as new species of Coregonidae, in the genera *Leucichthys* and *Prosopium*. Though some of the larger specimens reached the Academy in a poor state of preservation, having suffered in transit, most of the material has been placed in the Academy collection.

In explanation of the accompanying figures, almost all are enlarged or contracted to different dimensions. The various inserts are of different size from the usual lateral view given for the species. As dimensions are given for most all of the specimens, their proportions may be computed accordingly.

SALMONIDAE

Cristivomer namaycush (Walbaum)

One, 368 mm.?, July 4. Northwestern extremity of Nueltin Lake near mouth of Windy River.

One, 279 mm.?, August 5. Same data as preceding.

One, about one foot, August 18, northwestern extremity of Nueltin Lake, Windy Bay, ¾ mile off mouth of Windy River.

COREGONIDAE

LEUCICHTHYS Dybowski

Subgenus CISCO Jordan and Evermann

Leucichthys nueltinensis new species Figures 3 (head above), 4 (lateral view), 5 (nostrils) and 6 (first gill arch).

Depth $4\frac{1}{3}$; head $3\frac{7}{8}$, width $2\frac{1}{8}$. Snout 4 in head as measured from its own tip, which is level with center of eye; eye $4\frac{1}{2}$, $1\frac{1}{8}$ in snout, $1\frac{1}{8}$ in interorbital; maxillary $2\frac{1}{3}$ in head as measured from snout tip, reaches opposite front part of pupil and expansion about equals pupil; mouth well inclined, lower jaw protrudes slightly in front; jaw edges firmly coriaceous; interorbital 4 in head as measured from snout tip, convex. Gill rakers 40 (15 + 25), slender.

Scales 66 + 3 in lateral line; 29 predorsal; 8 above lateral line to dorsal origin, 7 below to anal origin. Ventral axillary scale $2\frac{1}{2}$ in fin length. Caudal base scaly. Six scales between ventral origins.

D. III, 9, I, first branched ray $1\frac{4}{7}$ in total head length, depressed fin reaching $1\frac{7}{8}$ to adipose fin origin; A. III, 11, I, lower fin edge concave, first branched ray $2\frac{1}{10}$ in total head length; least depth of caudal peduncle $3\frac{1}{10}$; adipose fin length $3\frac{1}{8}$; pectoral $1\frac{2}{3}$, reaches $1\frac{7}{8}$ to ventral origin, rays I, 14; ventral rays, I, 10, fin $1\frac{4}{7}$ in total head length; caudal $4\frac{1}{6}$ in rest of fish, well forked.

Color in alcohol largely grayish, sides and lower surfaces paler to silvery white. Under surfaces of chest, head and belly white. Dorsal and caudal grayish, outer membranes of former little deeper gray. Adipose fin gray. Lower fins all more or less whitish. Both ventral and anal show dark gray pigment dots, or minute to small spots, of dark gray. As seen from below, hind or inner borders of pectoral broadly pale and ventrals show dark dusting through membranes and fin rays.

A.N.S.P., type, no. 71740. (Original number 588.) Northwestern extremity of Nueltin Lake, Windy River, ¼ mile above its mouth, southwestern Keewatin. October 21, 1947. Fred Schweder, Jr., and Francis Harper. Length 228 mm. Captured with an axe-handle at night.

L. nueltinensis appears to represent a northern form of *L. nigripinnis* (Gill) in darkened pigmentation in the fins, though with a more or less subdued appearance. The dark dots are all more or less segregated medially on the lower fins. They are far less extensive and do not form as blackish borders, so strikingly shown in Hudson's colored figure, as published by Jordan and Evermann.[1] These authors give the gill rakers 51 (18 + 33) and according to Koelz (1929) they are 46 to 50 for Great Lakes material, counts all in excess of those I find in *L. nueltinensis*. The last is also further distinguished by its more slender or subelliptical body, protruding mandible, distinctly concave lower anal fin edge and its different head contour.

Vernacular name.—Nueltin Cisco.

(Named for Nueltin Lake.)

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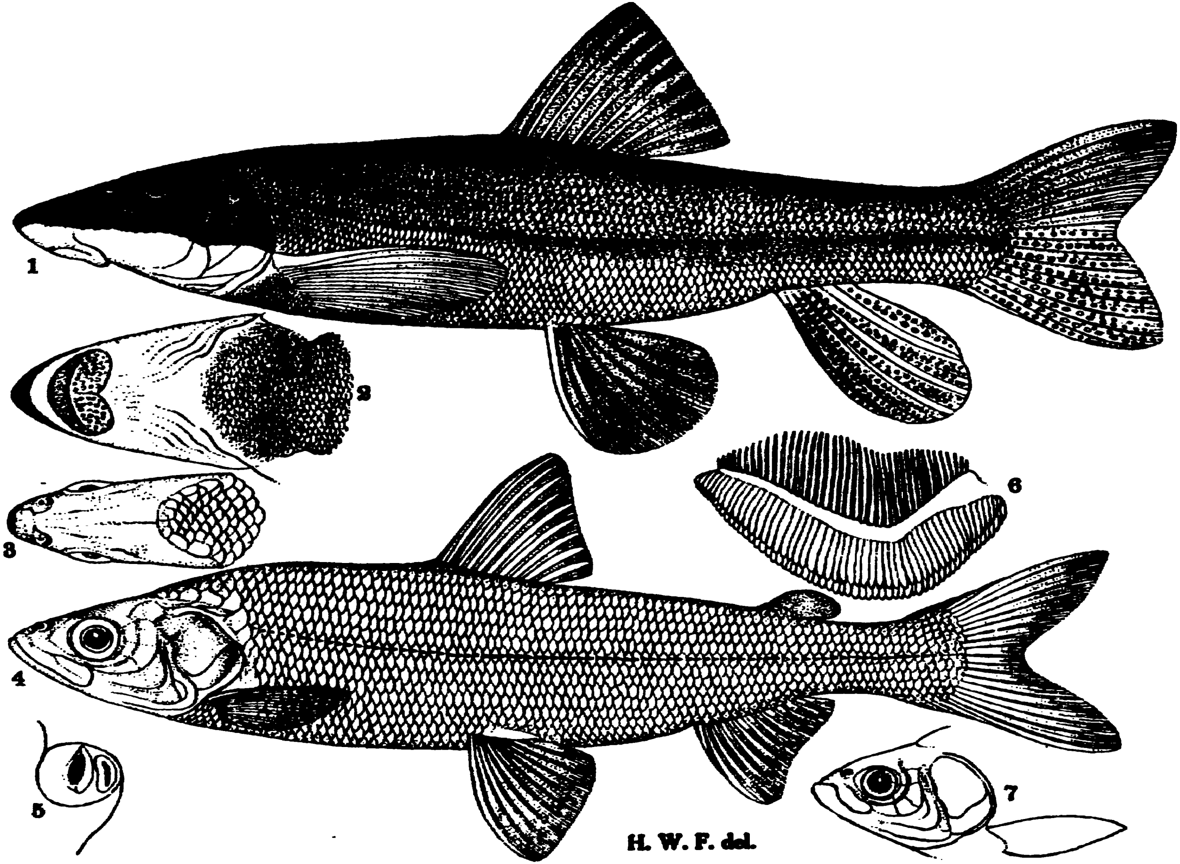
[1] Bull. Bur. Fisher. (U. S.), vol. 29, 1909 (Feb. 7, 1911), p. 26, pl. 4.



Figs. 1-2.—*Catostomus catostomus* (Forster). 465 mm. Figs. 3-6.—*Leucichthys nueltinensis* n. sp. 228 mm. Type. Fig. 7.—*Leucichthys* sp. Head 85 mm.

differs from the figure of the type of *L. zenithicus*, as published by Jordan and Evermann (1911), in the shorter pectoral, more slender body and smaller head. According to Dymond (1943) the gill rakers for *L. zenithicus* are given as 34 to 38 and the scales as 64 to 76, with the statement, "A low number of scales is a characteristic feature of *zenithicus*."

Vernacular name.—Churchill Cisco.

(Named for Churchill, the type locality.)

Prosopium hearnei new species Figures 12 (head above), 13 (lateral view), 14 (nostrils) and 15 (first gill arch).

Depth 4⅔; head 5⅓, width 1⅘. Snout 3⅓ in head, tip level with lower edge of eye; eye 4½ in head, 1⅖ in snout, 1⅗ in interorbital; maxillary reaches about ¾ to eye, length 4 in head; mouth small, with very short gape, without inner mandibular symphyseal tubercle, though each mandibular ramus well elevated inside mouth; jaw edges firmly coriaceous; interorbital 3, convex. Gill rakers 21 (9 + 12), short points.

Scales 90 + 5 in lateral line; 9 above to dorsal origin, 8 below to ventral origin, 8 below to anal origin; 32 predorsal. Scales in lateral line distinctly smaller than either in rows above or below. Lateral line and 4 parallel rows of scales above and 5 rows below with rounded pearl organ on center of each scale; also some scattered pearl organs on anterior part of predorsal. Caudal fin rather broadly scaled basally. Ventral with pointed axillary scale about ⅓ length of fin. Base of adipose fin with a narrow band of small crowded scales. Eight scales transversely at ventral fin origins.

D. III, 11, first branched ray 1⅓ in head and depressed fin reaches 2 to origin of adipose fin; A. III, 9, I, first branched ray 1½ in head, lower fin edge very slightly emarginate; adipose fin length 2⅓; pectoral 1⅒, rays I, 14, reaches 1⅗ to ventral; ventral rays I, 10, fin 1⅓ in head; caudal well emarginate, length 4¾ in rest of fish.

Color in alcohol with back brown, edge of each scale slightly darker. Sides and under surfaces whitish. Pearl organs on sides of body each conspicuously white. Upper surface of head with many small scattered underlaid dark gray spots. Dorsal, adipose fin, and caudal grayish, rays of first and last appearing darker. Pectoral gray, little darker above. Ventral whitish, with inner basal region grayish. Anal whitish, slightly pale gray medially.

A.N.S.P., type, no. 71743. (Original number 586.) Northwestern extremity of Nueltin Lake, Windy River, ¼ mile above mouth, southwestern Keewatin. October 10, 1947. Length 353 mm. Formalin specimen, later placed in alcohol.

A.N.S.P., paratype, no. 71743. (Original number 585.) Same data as type. Length 330 mm.

A.N.S.P., paratype, no. 71744. (Original number 587.) Same data as type. Length 340 mm.

"On October 11 the following color description was drawn up from three fresh specimens, comprising the type and two paratypes (original nos. 585-587), as listed above: head dark olive above, with small dusky spots; sides of head, and iris, pale brassy; dorsum light olive, with dusky margins to scales; sides verging toward pale brassy, the scales with spawning excrescences in nos. 586 and 587, but not in no. 585; lower sides dull yellowish; gular region and entire venter silvery white; dorsal fin rays dusky, the membrane mostly plain, with a few obscure spots; adipose mostly plain, with a few obscure dusky spots; caudal dusky, with a faint orange-red tinge; anal, ventrals, and pectorals dull orange, with dusky punctulations along rays; basal portion and part of margin of the anal colorless in one or two of the specimens; ventrals with pale margins; anterior margin of pectorals dusky, posterior margin colorless. This is evidently the breeding coloration." (F. H., MS.)

One, 240 mm. to base of caudal. Northwestern extremity of Duck Bay, near mouth of Windy River. July 1. (Original number 518.) Found in the stomach of *Esox estor,* and since the hind end of the fish was too much digested, only the head was preserved.

One, 405 mm. Northwestern extremity of Nueltin Lake, mouth of Windy River. July 10. (Original number 534.) D. III, 10, I; A. III, 10, I.

One, 335 mm. Same data as preceding. (Original number 540.) July 27.

One, immature. Same data as preceding. (Original number 566.) August 5.

The paratypes show:

Depth $4\frac{3}{5}$ to $4\frac{1}{2}$; head 5 to $5\frac{1}{3}$. Snout $3\frac{7}{8}$ to 4 in head; eye $4\frac{3}{5}$ to $4\frac{2}{3}$; maxillary $4\frac{1}{4}$? to $4\frac{2}{3}$; interorbital $3\frac{1}{10}$ to $3\frac{3}{5}$. D. III, 11, I; A. II, 10, I or III, 9, I. Scales 83 to 90 + 5 or 6 in lateral line; 9 above to dorsal; 8 below to ventral; 36 or 37 predorsal. In all the specimens the body is well compressed with flattened sides.

Evidently the spotted coloration of the upper surface of the head, as well as several structural characters, such as the increased number of gill rakers, proportions, design of the pearl organs, etc., are distinctive. Thus Preble's Round Whitefish[2] has 17 gill rakers and no spotted head. The type of that form was 540 mm. in total length, compared with a maximum of 405 mm. among the present series of *P. hearnei.*

In describing a Yukon specimen of *Coregonus quadrilateralis* (Richardson), Jordan and Evermann remark (1911) "the species certainly does not occur in the Winnipeg basin, [and] it may be questioned whether this Yukon fish is not a distinct species of *Prosopium* separate from the ordinary *Coregonus quadrilateralis.*" It is noted with 16 (6 + 10) gill rakers.

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[2] *Coregonus preblei* Harper and Nichols, Bull. Am. Mus. Nat. Hist., 41, art. 2, Sept. 22, 1919, 266, pl. 15, fig. 2. Tazin R., about 1 mile above its confluence with the Taltson R., Mackenzie, Canada.

Dymond has listed two specimens as the Asiatic *Prosopium cylindraceum*[3] from Churchill and Hudson Bay, in his table 6, with the statement that they "varied widely from the usual type. They were long, slender and compressed, with overhanging snouts," but no other features were revealed.

Vernacular name.—Hearne's Round Whitefish.

(Named for Samuel Hearne, pioneer explorer and naturalist of the Barren Grounds about Nueltin Lake in the winter of 1770-1771.)

Coregonus atikameg atikameg Bajkov

Figures 16 (head above), 17 (lateral view), 18 (nostrils) and 19 (first gill arch).

Depth 4; head 4½, width 2. Snout 4 in head, with its tip in front level with lower edge of pupil; eye 4⅙ in head, 1⅒ in snout, 1⅙ in interorbital; maxillary reaches slightly beyond front edge of eye, length 3⅓ in head, expansion equals pupil; jaw edge firm and rather broadly coriaceous; interorbital 3¾ in head, convex. Gill rakers 28 (11 + 17).

Scales 77 + 5 in lateral line; 9 above to dorsal origin, 8 below to ventral origin, 7? below to anal origin; 30 predorsal. Band of small scales along base of adipose fin. Caudal base rather broadly scaled. Ventral with pointed axillary scale ⅓ fin length. Seven scales between ventral origins.

D. III, 9, I, first branched ray 1 in head, depressed fin reaches 1⅖ to origin of adipose fin; A. III, 11, I, lower edge straight, first branched ray 1⅖ in head; adipose fin length 2⅖; least depth of caudal peduncle 2½; pectoral 1⅕, rays I, 16, fin reaches 1½ to ventral origin; ventral 1⅓ in head, rays I, 10, fin reaches 1½ to anal.

Color in alcohol with back gray brown, sides and lower surfaces pale, evidently bright silvery white in life. Iris now slate, evidently pale or whitish in life. Fins all more or less brownish, with dorsal, anal and ventral with dark gray to blackish on membranes terminally.

Length 250 mm. Churchill River, Churchill, Manitoba. July 5. Captured in seine in brackish water. John Ingebrigtsen, collector.

Also another, same data shows:

Depth 4; head 4⅓. Snout 4 in head; eye 4⅖; maxillary 3¾; interorbital 4¼. Scales 78 + 4 in lateral line; 9? above, 9? below to ventral origin, 9 below to anal origin; 27 predorsal. Length 230 mm. Agrees with the preceding in coloration. As most of the scales have fallen, the scale counts are from the scale pockets.

Although I have identified these specimens with *Coregonus atikameg* Bajkov,[4] the original description is not only insufficient in detail, but is also without indication of fundamental items. The incompletely crude outline figure of the head contributes little further of value, not to mention any reference to the dimensions of the specimens. Agreement, however, appears

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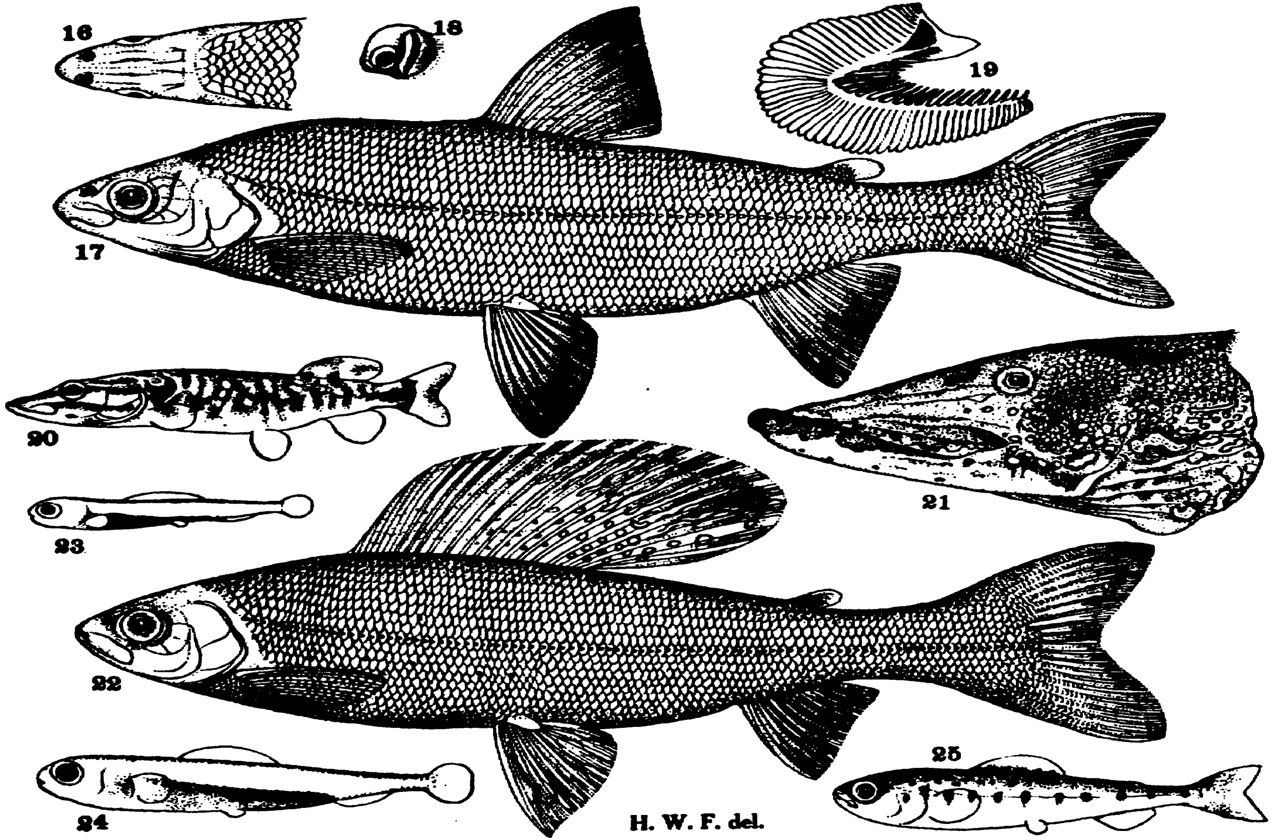
[3] Contrib. Roy. Ontario Mus. Zool., vol. 24, pt. 2, 1943, p. 200.

[4] Int. Rev. Hydrobiol., vol. 29, heft ½, 1933, p. 20, text-fig. (outline head to right). Hudson Bay, Manitoba.



H. W. F. del.

Figs. 16-19.—*Coregonus atikameg atikameg* Bajhov. Length 250 mm. Figs. 20-21.—*Esox estor* Le Sueur Length 48 mm., head 305 mm. Figs. 22-25.—*Thymallus signifer* (Richardson). (Respectively, no. 581, 408 mm. no. 533, 15 mm.; no. 539, 18 mm.; no. 577, 45 mm.).

to be found in the slender body, the dark color of both back and fins, also the scales and the dorsal and adipose fins without black spots; upper profile of the head nearly straight, the long maxillary nearly reaching the eye (nearly to the pupil in my specimens), and the habitat in brackish and salt water. Prof. Bajkov says, "the number of the circum-orbital bones is seven, i.e., more than in *clupeaformis* which has usually only six." Other characters as given in his table show fewer gill rakers (25).

Although Dymond[5] declares, "*C. atikameg* is undoubtedly synonymous with *clupeaformis*," this is a statement I feel unable to agree with, at least until more definite evidence is forthcoming. In his discussion of the subspecies in *Coregonus*, "*hudsonius*" is listed, though I have been unable to find this name elsewhere.

In the "summary,"[6] *C. nelsoni* Bean,[7] *C. kennicotti* Bean, *C. odonoghuei* Bajkov and *C. atikameg* Bajkov are all "reduced to synonymy . . . as synonyms of *C. clupeaformis*." I have examined examples of both of the first two species listed, and both appear to me closely related, or if synonymous, perhaps to be identified with the earlier *C. richardsonii* Guenther. Both differ from the present species in having only 22 and 20 gill rakers respectively. Dymond's count for *C. kennicotti* is 20 or 21 and for *C. nelsonii* 20 to 23.[8]

Coregonus atikameg manitobensis Bajkov

Adult female, 535? mm. (Original number 578.) Northwestern extremity of Nueltin Lake, Windy Bay, ¾ mile off mouth of Windy River. September 10.

Adult male, 560 mm. (Original number 580.) Same data. September 16.

Prof. Bajkov says this whitefish is "very abundant in all the deep lakes of Northern Manitoba, north of the Pas, where the common whitefish *C. clupeaformis* does not occur at all. Its colour, shape and proportional measurements are very similar to the anadromous form. Its very large adipose fin is half covered with small scales. This fish occurs also in the Nelson and Churchill rivers and probably in all other rivers north of Churchill in the Northwest Territories, where it is the most important food for natives and their dogs."

Roughened scales from a *Coregonus*, taken in the Windy River, 2 miles above its mouth, October 2, are now too dried out to show any modification. All are detached, appear smooth and apparently leave no scars such as are seen on those of certain cyprinoid fishes.

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[5] Contrib. Roy. Ontario Mus Zool., vol. 24, pt. 2, 1943, p. 195.

[6] Contrib. Roy. Ontario Mus. Zool., vol. 24, pt. 2, 1943, p. 228.

[7] Proc. Acad. Nat. Sci. Phila., 1905, p. 362.

[8] Contrib. Roy. Ontario Mus. Zool., vol. 24, pt. 2, 1943, p. 183.

THYMALLIDAE

Thymallus signifer (Richardson) Figures 22 (lateral view no. 582), 23 (fry no. 533), 24 (fry no. 539), and 25 (immature no. 577).

One, 383 mm. Northwestern extremity of Nueltin Lake, near mouth of Windy River. July 6. D. VII, 14, I; A. IV, 10, I. Predorsal scales 25. (Original no. 521.)

One, adult. Same data as preceding. July 7. (Original no. 522.)

Five, 15 or 16 mm. Windy River, ¼ mile above mouth. July 20. (Original no. 532.)

Two, both 15 mm. Data as for preceding. (Original no. 533.)

Twelve, 15 to 18 mm. Locality same as preceding. July 26. (Original no. 539.)

Six, 22 to 25 mm. Same locality. August 1. (Original no. 541.)

One, 25 mm. Locality same as preceding. August 3. (Original no. 564.)

Three, 31 to 34 mm. Same locality as preceding. August 12. (Original nos. 569, 570, 571.)

One, 39 mm. Same locality as preceding. August 19. (Original no. 573.)

One, 330 mm. Same locality as preceding. August 29. Caught on hook with blow-fly as bait. (Original no. 576.)

One, 45 mm. Same locality as preceding. August 30. (Original no. 577.)

Four, (one immature, others 284 to 408 mm.). Same locality as preceding. October 10. (Original nos. 581 to 584.) Largest with D. VIII, 14; A. III, 10; pectoral I, 14; ventral I, 9. Scales 90 + 5 in lateral line.

One. Same locality as preceding. October 21. (Original no. 589.)

OSMERIDAE

Mallotus villosus (O. F. Mueller)

Two, 125 and 145 mm. Churchill, Manitoba. July 5. John Ingebrigtsen.

CATOSTOMIDAE

Catostomus catostomus (Forster) Figures 1 (lateral view) and 2 (head below).

Adult male, 465 mm. Northwestern extremity of Nueltin Lake, near mouth of Windy River. July 5. (Original number 520, specimen as figures 1 and 2.) Color in alcohol with back dark brown, blackish on top of head. Color sharply contrasted along sides of head from white color of under surfaces. Dorsal and caudal fins dark gray brown, and lower fins pale to whitish.

One, 355 mm. Mouth of Windy River. July 24. (Original no. 535.) Shows: head 4; D. II?, 10; A. II, 7, I. Snout 2½ in head; eye 7, 4 in snout, 3½ in interorbital.

ESOCIDAE

Esox estor Le Sueur Figures 20 (immature) and 21 (head of no. 517).

Head 305 mm. long, from large example, 1084 mm. in total length, adult female. Duck Bay, near mouth of Windy River. July 1. (Original number 517.)

Immature, 48 mm. Northwestern extremity of Nueltin Lake, Windy River, ¼ mile above mouth. August 3.

GADIDAE

Lota maculosa (Le Sueur)

One, 290 mm. Northwestern extremity of Nueltin Lake, Windy River, ¼ mile above mouth. August 9. (Original no. 568.) Head 4¾; eye 5¼ in head, 1¾ in interorbital. D. 10—77; A. 70. Pectoral 1½ in head.

Adult male, 696 mm. Windy Bay, ¾ mile off mouth of Windy River. September 16. (Original no. 579.) Head 4⅛; eye 9⅓ in head, 3 in snout, 2⅘ in interorbital. D. 13—76; A. 79. Pectoral 1⅘ in head.

One, 330 mm. Windy River, ¾ mile above mouth. December 1. (Original no. 590.) Head 5¼; eye 6 in head; 2 in snout, 1¾ in interorbital. D. 11—75; A. 80. Pectoral 1⅗ in head.

GASTEROSTEIDAE

Pungitius pungitius (Linnaeus)

One, 50 mm. Duck Bay, near mouth of Windy River. July 1. (Original no. 516.)

Four, 30 to 37 mm. Josie's Bay, a westerly arm of Windy Bay. July 12. (Original nos. 528 to 531.)

One, 32 mm. Northwestern extremity of Nueltin Lake, Windy Bay. August 18. This specimen saved from 7 found in the proventriculus of an American Merganser (*Mergus merganser americanus*).

COTTIDAE

Cottus cognatus Richardson

Five, 40 to 53 mm. Northwestern extremity of Nueltin Lake, Windy River, ¼ mile above mouth. July 9. (Original nos. 523 to 527.)

Three, adults. Same locality as preceding. July 24. (Original nos. 536 to 538.)

Twenty-two, 28? to 90? mm. Same locality as preceding. August 3. (Original nos. 542 to 563.)

Two, 28? to 34? mm. Same locality as preceding. August 19. (Original nos. 574 and 575.)

Five, 64 to 78 mm. Probably from Dawson Inlet, Keewatin. Summer of 1938. D. VIII to XI, 15 to 17; A. 10 to 13. John Ingebrigtsen, collector.

FISHES OF THE NUELTIN LAKE EXPEDITION, KEEWATIN, 1947. PART 2—HISTORICAL AND FIELD NOTES

BY FRANCIS HARPER

The present paper is one of a contemplated series of reports on the fauna and flora collected and observed during the course of this expedition. The entire investigation was made possible through a grant-in-aid provided by the United States Office of Naval Research and administered by the Arctic Institute of North America.

Nueltin Lake lies in the midst of what was virtually, until 1945,[1] a biologically virgin territory extending between Yathkyed Lake and the Thelon River on the north, Hudson Bay on the east, Reindeer Lake on the south, and Athabaska and Great Slave lakes on the west. This territory, comprising approximately 150,000 square miles, was thus one of extraordinary appeal to the student of the Arctic and Subarctic fauna and flora. Nueltin Lake, about 100 miles in length, had not been surveyed, and on the latest official maps in 1947 its outline was represented merely by broken lines. The Keewatin-Manitoba boundary crosses the lake toward its southern end.

It was a very great privilege to be able to spend a period of more than six months (May 31 to December 4) in intensive biological studies about Windy River and Windy Bay, at the northwestern extremity of the lake. The trip from Churchill and return, about 250 miles each way, was made by air. So little information had been available concerning the fish fauna of this part of Keewatin that a particular effort was made to secure a complete representation of the local species and to gather together all possible bits of knowledge pertaining to their distribution, ecology, habits, economics, and general life histories.

In this pursuit I was ably assisted by all the resident members of the Windy River post, consisting of three brothers, Charles, Fred, Jr., and Michael Schweder (respectively 22, 18, and 10 years of age), and two Eskimo children, 15-year-old Anoteelik (a boy) and 5-year-old Rita (a girl). These generous friends used all manner of devices to further the cause, from gill-net, dipnet, seine, and hook to hands, cup, stick, and axe-handle! Special mention should be made of the information supplied by Charles Schweder and of the resourcefulness and energy of Fred Schweder, Jr., as a collector.

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[1] In that year T. H. Manning, traveling from place to place by air, investigated a number of localities between Nueltin Lake and Hudson Bay, thereby making a considerable reduction in the size of the zoological *terra incognita*. His report on the birds and mammals appeared in 1948.

Windy Bay comprises the northwestern arm of Nueltin Lake. It is perhaps 15 miles in total length and 4 or 5 miles in maximum width. The upper, narrower portion, about 4 miles long, lies east and west; the lower, wider portion, north and south. The depth near its head is known to be as much as 40 feet. Josie's Bay is a small westerly arm of Windy Bay about 6 miles from the head.

Windy River and Little River enter the bay at its head; their mouths are about a quarter of a mile apart. The former runs a course of about 15 miles from Windy Lake to Nueltin Lake, in a general east-northeasterly direction. Near its mouth it is about 50-60 yards wide and perhaps 8-10 feet deep. There are a number of rapids, all of which can be run by a canoe. There are also a number of expansions of the river, the principal one being Simons' Lake, about a dozen miles above the river's mouth. A few aquatic plants, such as sedges, *Potamogeton*, and *Hippuris vulgaris*, grow in coves or in quiet stretches.

Little River is a slightly smaller stream than Windy River, and perhaps 30 miles in length. It runs a general southerly or southeasterly course. There are numerous rapids and some expansions. The water in both rivers is moderately clear, and the bottom, in general, is rocky. The water in Windy Bay appears to be slightly clearer than that in the rivers. The temperature of the water near the surface in Windy River, a quarter of a mile above its mouth, was 44° F. on July 1, 56° on August 16, and 39° on September 3; in Windy Bay, 56° on August 15.

No fish life was noticed in the numerous tundra ponds in the vicinity. Probably many of them freeze to the bottom in the winter; and those that lack outlets could not be repopulated annually from the neighboring lakes or streams.

The surrounding country is predominantly Barren Grounds. There are, however, numerous patches of small timber, composed principally of black spruce and tamarack.

For some undetermined reason, 1947 was an unusually poor year for the larger food fishes in this general region. During July the yield from the nets was so meager that the sled dogs frequently went hungry, and even the human residents had a few fishless as well as meatless days. This year was also characterized by a tardiness of the seasons. Windy River did not break up till June 14, and there was still considerable ice on Nueltin Lake in early July. In the fall the lake did not become finally frozen till November 1, whereas this event takes place in September of some years. Strong rapids on Windy River were still open when I departed on December 4.

The gill-nets in general use here have a mesh of approximately 5½ inches. I brought also a net with a mesh of about 2½ inches, for the particular purpose of securing specimens of small or medium size suitable for scientific preservation. A 12-foot seine, a dipnet, plain hooks, and a few flies and spoon trolls completed the ichthyological equipment.

On the return trip the season's collection of 97 specimens, representing every species of fish known to occur in the waters about the north end of Nueltin Lake, reached Churchill in good condition. Before they started on their rail journey from that point, some one drained the alcohol from the main specimen tank and substituted water. On arrival at their destination two months later, the specimens in this tank had so far disintegrated that nearly all of them had to be discarded at once. Those so lost included all specimens of the Lake Trout, Common Whitefish, and Burbot. Mr. Fowler has thus been seriously handicapped in drawing up his taxonomic report on the collection, which constitutes part 1 of the present paper. Fortunately a considerable portion of the collection remained intact in a container of formaldehyde and in a number of vials and small cans of alcohol. Photographs of most of the species in the fresh state, both in black and white and in color, compensate in some slight degree for loss of the actual specimens.

In addition to the observations made at Nueltin Lake and its immediate vicinity, I have included a number of notes secured from several informants about fishes in neighboring areas, such as northern Manitoba. I am particularly indebted to Mr. John Ingebrigtsen for notes from the Churchill area and other portions of the west coast of Hudson Bay, as well as for certain specimens mentioned in Mr. Fowler's report. Mr. Ingebrigtsen's experience includes commercial fishing along the coast of the bay.

At the conclusion of the account of each species, I give references to previously published records of that species (or of closely related forms) in various parts of northwestern Canada—particularly Keewatin, northern Manitoba and Saskatchewan, and the eastern portions of the district of Mackenzie. An effort is made toward a summation of all known records from the district of Keewatin. Among the references given are some to the classic work (1795) of Samuel Hearne, the great pioneer explorer and naturalist of northwestern Canada. In the narrative of his journey past Nueltin Lake in the winter of 1770-71, he pauses to discuss certain fishes (p. 71). Although he does not furnish exact distributional data, we may assume that his discussion applies to the general region of Nueltin Lake. The only other information hitherto available concerning the local fishes consists of a few brief notes in Downes' book (1943).

The fish fauna of the Nueltin Lake region, as known at present, comprises only 11 species, distributed by families as follows: Salmonidae, 1; Coregonidae, 3; Thymallidae, 1; Catostomidae, 2; Esocidae, 1; Gadidae, 1; Gasterosteidae, 1; and Cottidae, 1. The complete absence of minnows (Cyprinidae) is perhaps worthy of note.

All the known freshwater fishes of this part of the Hudson Bay drainage are either identical with, or closely related to, species of the Athabaska Basin. At Wollaston Lake, and possibly at other points on the divide between the two drainage systems, the water flows out in both directions.

On the basis of a single season's experience, I should be inclined to list the larger fishes of the Nueltin Lake region in the following order of frequency: Common Whitefish, Red Sucker, Arctic Grayling, Lake Trout, American Pike, Hearne's Round Whitefish, Burbot, and Nueltin Tullibee.

Accounts of Species

Acipenser fulvescens Rafinesque. Lake Sturgeon.

Sturgeons were reported by John Ingebrigtsen as occurring up the Churchill River and also in the Nelson River. They are caught on hooks, he said.

J. W. Tyrrell states (1908: 242) that the species is "plentiful in the Nelson and some other rivers" flowing into Hudson Bay. Walker (1931: 474) and Vladykov (1933: 42) also report it from the Nelson River.

Cristivomer namaycush (Walbaum). Lake Trout. Figure 26.

The Lake Trout is a favorite fish of Arctic and Subarctic travelers, and it figures in practically all the tales of exploration in the Canadian Northwest from Hearne's time (1769) to the present. This is probably the largest as well as the most toothsome fish of the Nueltin region. While primarily an inhabitant of the lakes, it is also found in the rivers in the early part of summer and in the fall. Fred Schweder, Jr., remarked in mid-August that it leaves Windy River at that season; he had not endeavored to take any there during the preceding two or three weeks. It is said to return to the river when the Common Whitefish begin to come downstream in the fall (toward the end of August). In the opinion of Charles Schweder, the Lake Trout does not like dirty water; it is for this reason, he believes, that it leaves Little River for deeper water when this stream becomes slightly turbid in summer.

On June 24, ten days after the "break-up" in Windy River, I observed an approximately 28-inch Lake Trout as it followed a spoon troll into the rocky shallows at the river's mouth. From July 20 to 22 three of these fishes, ranging from about 4 to 11 pounds, were taken on a troll or a baited hook several hundred yards farther upstream. Others were noted during the fall fishery operations in an expansion of Windy River 2 miles above its mouth. For example, on October 2, when the nets were lifted after an interval of five or six days, about a dozen Lake Trout were included in the total catch of about 200 fish (mainly Common Whitefish). Of seven or eight individuals that were opened up, all but two were males. Another individual taken at this place on October 22 was approximately 3 feet long and weighed 19.5 pounds.

From July 4 to September 25, while gill-nets were kept in position in Windy Bay, off the mouth of Windy River, Lake Trout were taken in small numbers every few days. The netting places ranged from 3-12 feet deep, with rocky bottom, to 30-40 feet deep, with mud bottom; the water in the bay (as well as in the river) was moderately clear. Among those individuals of which I kept a record as to total length, the smallest (August 4) was 265 mm. Two others on this day were 690 and 940 mm. in length, and 4.75 and 15 pounds in weight. Others taken during the season (chiefly in Windy Bay) ranged up to 20.5 pounds; common sizes seemed to be 4-5 pounds and 8-12 pounds. Two from Windy River, September 25, were 607 and 910 mm. in length, and 4 and 18 pounds in weight. Nothing seems to be known locally concerning the species during the first few years of its life; it is then too small to be taken in the gill-nets with mesh of the ordinary commercial size (5½ inches).

Information as to spawning size and season was obtained from a number of females: July 5, off mouth of Windy River, individual of 3.75 pounds, with many 1-mm. ova; July 21, river, 4-5 pounds, ovaries becoming well developed, with very distinct ova; August 4, off river's mouth, 4.75 pounds, ova likewise developing; August 5, Windy Bay, 8-9 pounds, with ova about 4 mm. in diameter; October 2, river, two females with quite small ovaries, evidently having finished spawning, or perhaps not having spawned at all that year (*cf.* Miller, 1947: 38).

Food habits were revealed by various stomach examinations. July 5, off mouth of Windy River, individual of 20.5 pounds: fin rays and vertebrae of a fish. July 5, off river's mouth, 3.75 pounds: insect larvae. July 20, river, about 4 pounds: a fly the size of a blowfly and the remains of a fish perhaps 10 inches long. July 21, river, 4-5 pounds: an insect larva. July 22, river, about 11 pounds: fin rays and vertebrae of a sizable fish. August 4, off river's mouth, 4.75 pounds: two flies (tabanids?). August 4, off river's mouth, 15 pounds: a Red Sucker over a foot long. October 2, river, approximately 3 feet in length: a Lake Trout of about 12 inches. October 22, river, 19.5 pounds: a Moray of about 12 inches, a Lake Trout of about 13 inches, and the vertebrae and caudal fin of what appeared to be a Red Sucker. Cannibalism thus contributes toward limitation in the numbers of the Lake Trout.

In selecting a fish for the table, a resident will make a longitudinal slit in its side to ascertain the color of the flesh and also the fatness of the individual. Red or orange-colored flesh is preferred to white. Miller (1947: 38) correlates the flesh color with spawning ripeness, the ripening fish being pale and non-ripening fish red. At the beginning of the fishing season in early summer, the Lake Trout is locally preferred to all other fishes, but later on the Common Whitefish may become the first choice, while the Grayling apparently runs third. As far as my observation went, the Lake Trout was invariably fried. The Kazan River Eskimos, however, consume this and other fishes in the raw state. For use as dog feed and fox and wolf bait, the Lake Trout is less important than the far more numerous Common Whitefish.

The following color notes were made on July 5 on a 20.5-pound male (fig. 26) taken that day off the mouth of Windy River: above (including top of head) with pale sea-green spots on a dusky reticulated ground color; dorsal similar, posteriorly edged with dull reddish orange; from just above the lateral line to mid-venter (and forward to below the eye) the spots increasing in size and becoming gradually buffy or pale golden (bright golden above and before the anal); caudal spotted somewhat like dorsal, but more pronouncedly edged all round with orange-red; anal with a few spots on a pale dusky ground color at base, but mostly orange-red, its anterior edge (distal $\frac{3}{5}$) whitish; ventrals much like anal, but more deeply orange-red; pectorals largely dusky, with indistinct spots along rays, the broad posterior edge orange-red, the anterior edge pale orange proximally and whitish distally; throat silvery white; chest similar, with dusky punctulations; mid-venter creamy, with punctulations. Total length, 1010; length to base of caudal, 850; depth, 200; head, 270; tip of snout to end of maxillary, 155; eye, 26; orbit, 34 mm.

A 3.75-pound female, taken at the same place and date, was much paler, virtually lacking the golden coloration.

Each of the two last-mentioned specimens was infested with intestinal worms. One end of nearly every worm seemed to extend down into one of the numerous pyloric caeca. Badly preserved material was identified by Dr. Richard B. Miller, of the University of Alberta, as probably *Eubothrium salvelini* (Schrank), a cestode of the order Pseudophyllidea.

Three small Lake Trout, approximately 12-14 inches in length, were preserved on July 4, August 5, and August 18. They were taken in Windy Bay, off the mouth of Windy River. Such small specimens are occasionally caught by their teeth in the large-meshed gill-nets, which would not ordinarily hold their bodies.

Charles Schweder states that the Lake Trout is more numerous at the south end of Nueltin Lake than at the north end; that there are a few in the Little Dubawnt River, which flows into Dubawnt Lake from the south, and likewise in the upper Kazan River, below Ennadai Lake. Joe Highway reported to me its occurrence in a lake along the headwaters of Putahow River, on the Keewatin-Manitoba boundary.

Some of the nearest localities to Nueltin Lake from which the Lake Trout has been recorded are: " lakes far inland " from Hudson Bay (Pennant, 1792: ccxcviii); "Shee-than-nee" (Tadoule?) Lake, Manitoba, apparently Nueltin Lake or vicinity, and Great Slave Lake (Hearne, 1795: 15, 71, 249); God's Lake, Manitoba (Richardson, 1823: 709); Winter Lake, Mackenzie (Richardson, 1836: 179); Great Slave Lake (Kennicott, 1869: 205; Rawson 1947*a*: 57); Artillery Lake (J. W. Tyrrell, 1924: 20); Thelon River, Schultz Lake, near Baker Lake, and Great Bear Lake (Hanbury, 1904: 40, 45, 69, 241); Dubawnt River above Dubawnt Lake and " all the lakes and streams tributary to " Hudson Bay (J. W. Tyrrell, 1908: 85, 242); Mackenzie Basin, including Athabaska, Great Slave, and Great Bear lakes (Preble, 1908: 510); Great Bear Lake (Anderson, 1913: 453; Miller, 1947: 37); Lake Athabaska (Harper and Nichols, 1919: 269; Kendall, 1924: 14; Rawson, 1947*b*: 78); Reindeer Lake (Buchanan, 1920: 99; Downes, 1943: 66); headwaters of Dubawnt River (Blanchet, 1927: 149); Artillery Lake, Hanbury and Thelon rivers (Critchell-Bullock, 1931: 34; Hornby, 1934: 109; Clarke, 1940: 113); Baker Lake (Hornby, 1934: 109; Pfaff, 1937: 6); and Windy River (Downes, 1943: 249). Among the above-mentioned localities, Nueltin Lake and the Thelon River (in part), Schultz and Baker lakes, and Windy River are in Keewatin.

Salvelinus alpinus (Linnaeus) subsp. Arctic Charr.

John Ingebrigtsen supplied me with the following information. This species apparently remains for the most part in tidewater, not ascending streams (such as the Churchill River) above rapids or falls. It spawns in August or September. He has secured these fish in Hudson Bay by setting gill-nets on tidal flats at low tide and picking them up at the next tide. If the nets were placed farther offshore, the whales and seals would tear them. He secured one fish (apparently near Churchill) of 26 pounds, with a length of 36 inches. At Dawson Inlet the species averages about 12 pounds, with some individuals reaching 18-20 pounds. At Chesterfield Inlet and Southampton Island the average is about 5-6 pounds.

Various forms of the Arctic Charr have been recorded from " Knapp's Bay " (Dawson Inlet) and Whale Cove, Keewatin, and near Churchill (Hearne, 1795: 395); from the Coppermine River and Boothia Felix (Richardson, 1823: 706 and 1836: 163, 167, 169, 171); from Maguse River and Eskimo Point (Birket-Smith, 1929: 119, as " sea-trout "); from a freshwater lake on Southampton Island (Henn, 1932: 1); from above and below Schultz Lake and in Baker Lake (Hornby, 1934: 109; Clarke, 1940: 114); from the Kazan River below Kazan Falls (Porsild, 1936: 9); and from Baker Lake (Pfaff, 1937: 6). Vladykov (1933: 18), in recording it from the vicinity of Churchill, remarks that is is not the Greenland Charr (*S.*

stagnalis). With the exception of the Coppermine River, Boothia Felix, and Churchill, the above-mentioned localities are in Keewatin.

Leucichthys nueltinensis Fowler. Nueltin Tullibee; Nueltin Cisco.

All my inquiries concerning the occurrence of a fish of this sort in Nueltin waters went for naught for some months. Apparently the residents had noticed such a fish neither in the water nor in the stomachs of Lake Trout or Pike. (In Lake Athabaska, on the other hand, *Leucichthys athabascae* may be readily noted in either way.) Thus I had come to the reluctant conclusion that there must be no Tullibee in the local waters.

However, about 10 p. m. on October 21, Fred Schweder, Jr., was using the light of a gas lantern to look for fishes in Windy River a quarter of a mile above its mouth. There he detected two or three individuals of about the same size and appearance, in the stony shallows within a rod of the shore, in moderately clear water up to 1 foot deep, with a good current. He managed to secure one of them by striking it with an axe-handle. In my absence from camp he thoughtfully placed the specimen in a tank of formaldehyde, realizing that it was something new to the region. I was immensely delighted the next day to find that it was a *Leucichthys*—that the Nueltin Lake region would no longer remain a blank space on any distributional map of the genus.

Charles Schweder, looking at the 228-mm. specimen, remarked that a similar but smaller fish occurs in the upper Kazan River, where the Eskimos catch it by hand among the rocks, but probably do not eat it unless very hungry. Anoteelik, an Eskimo boy from the Kazan, spoke of catching such fishes by hand. Michael Schweder thus caught one himself in June, 1947, in Goose River, a tributary of the Kazan. Joe Highway reported a Tullibee in Reindeer Lake, but did not know of the occurrence of such a species in Kasmere Lake nor at the south end of Nueltin Lake.

Tullibees or Ciscoes (genus *Leucichthys*) have been reported under a variety of specific names from many localities in the Athabaska-Mackenzie region and elsewhere in northwestern Canada; *e. g.*, by Richardson (1823: 711; 1836: 201), Bean (1881: 129), Hanbury (1904: 45, 124, 217, 242-248), Evermann and Goldsborough (1907: 100), Preble (1908: 507), Anderson (1913: 451), Harper and Nichols (1919: 267-269), Buchanan (1920: 98, 102), Kendall (1924: 12, 14), Critchell-Bullock (1931: 34), Bajkov (1932: 332), Walker (1931: 473), Dymond (1933: 8 and 1943: 214, 215, 218), Hornby (1934: 109), Clarke (1940: 115), Downes (1943: 66), Wynne-Edwards (1947*a*: 18 and 1947*b*: 28), Miller (1947: 37, 39), and Rawson (1947*a*: 59 and 1947*b*: 78). The only localities of previous record in Keewatin seem to be the following: Schultz Lake and Back's River (Hanbury, 1904: 45, 124); Thelon and Aberdeen rivers and Baker Lake (Clarke, 1940:

115, 123). The complex taxonomic relationships of the various representatives of the genus *Leucichthys* in northwestern Canada are much in need of being thoroughly worked out.

Coregonus atikameg atikameg Bajkov. Hudson Bay Whitefish.

A peculiar interest attaches to the diminutive *Coregonus* that inhabits the mouths of rivers entering the west side of Hudson Bay. It began to be noticed over two centuries ago, when the residents of Fort Bourbon (apparently located near the mouth of the Hayes River) were said to take " a white Fish something like a Herring, by much the best Fish in the World " (Dobbs, 1744: 22). Several years later, the clerk of the *California*, referring to the mouth of either the Hayes or the Nelson River near York Factory, wrote: " What we mostly catched with the Sein was a fish there called *Tettymeg*, much resembling a Dace, but larger, some weighing upward of three Pounds, but commonly about the Size of a good Herring " (Drage, 1749: 32).

Pennant, referring probably to the west side of Hudson Bay, says (1792: ccxcviii): " There is a lesser kind [of " Gwiniad " or Whitefish], called here the *Sea Gwiniad* . . . . They are very numerous in autumn, just when the rivers are frozen over, and are called here Tickomeg."

According to Richardson (1836: 196, quoting Hutchins), the Common Whitefish " is never seen in the tidal waters of Hudson's Bay "; but he adds in a footnote: " The ' Titymeg as big as a Herring,' mentioned in the narrative of the Voyage of the Dobbs and California as abounding in Hayes and Nelson rivers, within reach of the tidal waters of Hudson's Bay, is, I believe, of a different species, named by Mr. Hutchins *Winipeg-attihawmeg*, and by Pennant *Sea-guiniad*."

Hanbury may refer to the present form when he writes (1904: 5): " The white fish at York Factory are very small (four or six to the pound), and are caught with sweep nets of one-inch mesh a few miles up Hayes River." J. W. Tyrrell remarks (1908: 85) that these fish are " caught in the mouths of several of the rivers [entering Hudson Bay] by the Hudson's Bay Company, and salted in barrels for export."

Walker states (1931: 473-474) that Whitefish at Churchill have an average length of 14 inches, and an average weight of ¾ to 1 pound, while at Nelson the average weight is 1 to 1½ pounds. The maximum length reported by Dymond (1933: 4) for Churchill specimens is 403 mm. to the fork of the tail; the maximum weight, 814.6 gm. (28.75 oz.). The maximum length I recorded for specimens (of *C. a. manitobensis?*) from the Nueltin Lake region was 640 mm. to the end of the tail; the maximum weight, 6.25 pounds. Thus the difference in size between the estuarine form and that of the inland waters seems to be of real significance.

John Ingebrigtsen informed me that many Whitefish are fed to dogs in Churchill. The latter then become infested with tapeworms and remain in poor condition, no matter how much they eat, until they are treated with worm medicine. Bryan McKay reported Whitefish in Goose Creek, a tributary of Churchill River 10 miles south of Churchill; whether or not these are the small estuarine form (*atikameg*), I am unable to say.

Coregonus atikameg manitobensis Bajkov. Manitoba Whitefish. Figure 27.

This name is provisionally applied to the common large Whitefish of Nueltin Lake and neighboring interior waters of the Hudson Bay drainage. To distinguish it readily from the small, estuarine Hudson Bay Whitefish (*C. a. atikameg*) on the one hand, and from the Round Whitefish (*Prosopium*) on the other hand, I shall generally refer to it as the Common Whitefish.

In the Nueltin Lake region, as in the fresh waters of northwestern Canada generally, the larger forms of Whitefish are economically the most important members of the finny tribe. They can be eaten indefinitely without palling upon the human appetite, and they constitute a staple food for sled dogs. It fortunately happens that Whitefish are generally available in abundance.

I was impressed, from the first glance at the local specimens, with their different aspect from a common type in the Athabaska region—a proportionally larger head, a longer, more pointed, and perhaps darker snout, a less deep body, and virtual absence of a "hump." They bear a strong resemblance to the "peculiar dark, terete form of common whitefish" in Lake Athabaska figured by Rawson (1947*b*: 77, fig. 17); the latter is considered much less common than the other form in that lake. Aside from the Round Whitefish, this was the only type of Whitefish that I noted during the entire season of 1947.

Specimens that I photographed in 1914 at Thainka Lake, Saskatchewan, and in 1920 in the vicinity of Moose Island, Lake Athabaska, are obviously of the long-snouted type and close to or identical with Nueltin Lake specimens.

It was not until July 10, six days after the first setting of nets in Windy Bay, at the mouth of Windy River, that the first Whitefish (seven in number) were brought in. Thereafter the nets yielded these fish at least every few days until the end of October, when fishing was given up for the season. The nets were kept set till about September 25 in Windy Bay, in the situations mentioned in the account of the Lake Trout. Then operations were transferred to an expansion of Windy River 2 miles above its mouth.

The average weight of the Whitefish locally taken in the nets with a 5- or 5.5-inch mesh is said to be about 4 pounds. Of six specimens that

I weighed, the smallest was 2.25 pounds, the largest, 6.25 (average, 4.7). The total lengths of eight specimens ranged from 485 to 640 mm. (average, 562.1). I estimated at 17 inches (432 mm.) the length of one of the smallest specimens I examined. These few data indicate a considerably greater average length and weight for the local Whitefish than for those of either Lake Athabaska or Great Slave Lake (*cf.* Rawson, 1947*b*: 77).

Small mollusks apparently constitute a considerable proportion of the food of the local Whitefish. The stomach contents of two specimens from Windy Bay, July 19 and August 11, included the following mollusks: *Sphaerium* sp., *Valvata lewisi* Currier, *Lymnaea emarginata* (Say), and *Gyraulus arcticus* (Möller) (Wurtz, 1948). According to Charles Schweder, a few Whitefish enter the lower part of the Red River, just above its junction with Windy River southwest of Simons' Lake; they do this in the spring to feed upon the spawn of Red Suckers, but otherwise they seem to avoid the coffee-colored muskeg water of the Red River. On October 30 he reported that he had recently found eggs (of Whitefish?) in three out of four or five stomachs of this species that he had examined. The inferior mouth of the Whitefish is excellently adapted for scraping small mollusks and other food material off rocks or other portions of lake and river bottoms.

Parasitic copepods appear to be rather commonly present on the gills; specimens were collected on August 2. On October 2, in each of two females, about 17 and 20 inches in length, the fore part of the stomach was fairly lined with parasitic worms, their heads embedded; these were identified by Dr. Richard B. Miller, of the University of Alberta, as *Cyathocephalus truncatus*, a pseudophyllidean cestode. When Thomas Lamb, who operates large fisheries in the vicinity of The Pas, Manitoba, visited Nueltin Lake in August, he carefully examined some of the Whitefish for possible flesh parasites (perhaps *Triaenophorus*—cf. Rawson, 1947*a*: 57), but found none. Apparently the local residents have never noticed any.

As early as July 10, approximately three months before the actual spawning season, a female exhibited a considerable amount of roe. Another on July 19 was in similar condition. On August 11 some half-formed roe was cooked and eaten. On August 25 I recorded " good roe," and on September 10 " ovaries well developed." The foregoing specimens were taken in Windy Bay; the following, in Windy River 2 miles above its mouth. Among the large numbers netted on September 25 (fig. 27), the females were generally full of roe, which was being enjoyed by the fishermen; none of the fish were said to have spawned as yet. The Whitefish taken on October 2, to the number of nearly 200, seemed to be mainly females. One, about 20 inches in length, had full ovaries, with eggs about 2 mm. in diameter; another, about 17 inches, had such small eggs that it may not have been in spawning condition that year. On this day Charles Schweder pointed out, as an indication of the onset of the spawning season, a rough excrescence in the middle of scales on the sides. These excrescences, he said, would extend to the caudal and probably other fins and onto the head. Some of the fish taken on October 28 were very fat-looking. A 5-pounder was exuding 3-mm. eggs as it was brought ashore; it seemed to be largely spent, for very little roe remained in it. By October 30 Charles Schweder considered the spawning season practically over, since the fish had resumed feeding. Apparently very little food is taken while spawning is in progress.

I had frequent occasion to observe that Fred Schweder, Jr., when carving up a fish for the frying-pan, would discard a considerable portion of the back, extending from the head to the posterior end of the dorsal fin. When questioned as to the reason, he explained that the numerous fine bones in that portion (probably the pterygiophores in particular) made it less desirable for eating. The dogs would sometimes get the benefit of the discarded piece.

In October, on a trip up the Windy River, Charles Schweder treated me to roasted Whitefish ("poonas" of the Crees). A 6-pound fish, after evisceration, was impaled on a stick thrust lengthwise through it; the base of the stick was then stuck into the ground at a slant, supporting the fish in front of a large fire. After one side was sufficiently roasted, the campers fell to with forks on that side; then the fish was returned to the fire, with the opposite side toward the flames, and the roasting was completed. This method of cooking has the advantage of dispensing with any dishes.

When Charles started on a trip to Duck Lake by dog sleigh in late November, he took, as part of the load, several dozen frozen fish, at least most of them Whitefish, with an average weight of probably 4 pounds or more. These were to serve as dog feed. A day's ration for each dog, in winter traveling, is two such fish.

John Ingebrigtsen informed me that Common Whitefish, weighing up to 8 or 10 pounds, had been brought out by plane from Etawney Lake, 110 miles southwest of Churchill. Joe Highway reported this species in a lake on the upper course of Putahow River, on the Keewatin-Manitoba boundary. Of 1,500 fish he had put up at that lake for winter use in the fall of 1947, nearly all were Whitefish, of about the same size as those in Windy River. Charles Schweder reported this as the principal fish in the Little Dubawnt River, which enters the south end of Dubawnt Lake, and in the upper Kazan River, below Ennadai Lake. He considers the Whitefish of the south end of Nueltin Lake smaller than those of Windy Bay, but more numerous.

Autumn fishery.—Since the chief product of the autumn fishery operations on Windy River is the present species, these operations may be described here. Their chief object is to provide the winter's supply of dog feed and fox bait. There is very little consumption of fish during the winter by the human residents, who prefer Caribou meat. The operations are generally deferred until the temperature has dropped to a point where the fish will be preserved in the open air without undue deterioration during the ensuing months. Even if they do deteriorate too far for human consumption, they are still serviceable for dogs and foxes. Under these circumstances, they are not usually suspended on drying frames, as in the Athabaska and Great Slave lakes region, but are left lying on the bank, generally without being eviscerated. No drying frame was in use on Windy River in 1947. If some were occasionally used in former years, the fish were suspended by means of sticks laid across the frame. The sharpened sticks were thrust through the tail, not through the head, as with the Inconnu (*Stenodus*) on the Slave River. At intervals during the winter the fish are hauled away, as needed, on dog sleighs. Meanwhile the toll levied by Mink, Weasels, Foxes, and Canada Jays is said to be inconsiderable. If a good supply is obtained just before the " freeze-up," the fish may be placed in a storehouse at the main camp.

The place utilized for this fishery during some years past is an expansion of Windy River 2 miles above its mouth. Here the normal width of the river is doubled, trebled, or perhaps quadrupled, to an extent of, say, 200 yards. The current in this part is so gentle that the nets readily maintain the approximate position in which they are set, across the current. Those who attend to the fishing establish temporary quarters in a tent on the shore. The river remains open for a considerable period after the lakes freeze over. Even when the freezing of the lakes takes place in September, the river fishery may be conducted in October. By this time the Common Whitefish have been engaged for some weeks in a catadromous migration in connection with the spawning season. The direction of this migration is said to have been ascertained from the fact that the fish become entangled in the nets from the upstream side; also from their having been directly observed going downstream. They are presumed to come from Windy Lake (and perhaps other lakes) a dozen miles or more upstream, and to spend the winter in Nueltin Lake. They start coming down the river toward the end of August, and continue during September and October. In the meantime spawning obviously takes place, but there is little knowledge of the exact location. Very likely one place is the river expansion where the fishery is conducted. The Whitefish are never noticed while undertaking a return migration; it may occur during the winter or the spring while the river is still frozen.

The best time for netting the Whitefish in large numbers is said to be the middle of September. It is considered advisable, however, to postpone operations till October, when the fish will have a better chance to keep without undue spoiling. In 1947 the operations were started on September 24, but it proved to be an unusually mild autumn, and the fish taken that month did not remain in good condition. Fishing was suspended on October 30, after an exceptionally poor season. In a good season as many as 500 Whitefish are said to have been taken at a single lifting of two nets, each 300 feet in length.

When I visited the fish camp on September 25, Charles Schweder had taken, since setting 600 feet of nets the previous afternoon, 75 or more Whitefish, besides a small number of Lake Trout and Red Suckers and one Pike. On October 2, when the nets had not been lifted for five or six days, they yielded approximately 200 fish—mainly Whitefish, with perhaps a dozen Lake Trout, two Red Suckers, one Pike, and one Grayling. Among a number taken on October 28, a 5-pound female had a total length of 555 mm.; depth, 148; width, 73.

In fishing one of the nets on the last-mentioned date, Charles Schweder stood up amidships in a 16-foot canoe, stooping over to take hold of the net with his hands, and thus pulling the canoe along as he selected fish from it. He had to pause to disentangle them, sometimes apparently breaking the twine to do so. The nets become torn and woefully snarled in a short time, and seem to be generally discarded after a single season's use. The fish enter the nets mainly by night, and during heavy runs the nets may be lifted several times in the course of a night.

Among the numerous previous records of Common Whitefish from northwestern Canada (many of them under the name of *Coregonus clupeaformis*, although it is hardly likely that this name is applicable to the fishes of this region), the following are some of the more important or interesting: vicinity of "Shee-than-nee" (Tadoule?) Lake, Manitoba, Kazan ("Cathawhachaga") River, apparently Nueltin Lake or vicinity, and Great Slave Lake (Hearne, 1795: 16, 36, 71, 249, as "tittemeg"); mouth of Coppermine River and Bathurst Inlet (Richardson, 1823: 710); "all the interior lakes of America, from Erie to the Arctic Sea" (Richardson, 1836: 195); Great Slave Lake (Kennicott, 1869: 206; Seton, 1911: 183); Anderson River (MacFarlane, 1890: 38); Dubawnt Lake (J. B. Tyrrell, 1897: 164F); Artillery Lake (J. W. Tyrrell, 1924: 20); Thelon and Back's rivers, Schultz and Great Bear lakes (Hanbury, 1904: 40, 45, 124, 243); Dubawnt River above Dubawnt Lake (J. W. Tyrrell, 1908: 85); "nearly every stream and lake throughout the north" (Preble, 1908: 505); Reindeer Lake (Buchanan, 1920: 98; Downes, 1943: 66); Lake Athabaska and Athabaska River (Kendall, 1924: 9); Great Slave, Artillery, Aberdeen, and Schultz lakes (Critchell-Bullock, 1931: 34); Artillery Lake, Hanbury River, and vicinity of Aberdeen and Schultz lakes (Hornby, 1934: 109); Baker Lake and Thelon River (Clarke, 1940: 115; Dymond, 1943: 196); Nueltin Lake and Windy River (Downes, 1943: 188, 193, 249); Yukon and Mackenzie rivers (Wynne-Edwards, 1947*a*: 18-19 and 1947*b*: 28); and Great Bear Lake (Miller, 1947: 37). Two different forms (probably specifically distinct) are found in Great Slave Lake and also in Lake Athabaska (Rawson, 1947*a*: 56, fig. 10, and 1947*b*: 76-77, figs. 16-17). Among the above-mentioned localities, the following are in Keewatin: Dubawnt and Nueltin lakes and Back's and Thelon rivers (in part); Aberdeen, Schultz, and Baker lakes, and Kazan and Windy rivers.

Prosopium hearnei Fowler. Hearne's Round Whitefish. Figure 28.

This is evidently a far less numerous species than the Common Whitefish (*Coregonus*). A factor in the paucity of records is the comparatively small size of its body, which generally enables it to slip through the commercial gill-nets with a mesh of approximately 5½ inches.

My first intimation of its presence in Nueltin Lake came on July 1, when a partly digested specimen, apparently of this species, with a length of 240 mm. to the base of the caudal, was found in the stomach of a 6¾-pound Pike, which had been captured in Duck Bay, near the mouth of Windy River. On July 10 two other specimens, approximately 15-16 inches in total length, were brought in from a small-meshed net just below the river's mouth, where the water was moderately clear and the bottom rocky.

Fred Schweder, Jr., who secured these two specimens, recalled having netted only two others in previous years. However, he had killed a considerable number in the shallow edge of Windy River on October nights, by striking them with a paddle; nine had been thus secured in a single night. They were then resting quietly near the shore; but they had never been noticed in the daytime. They were said to start moving up the river about the first of October, and to continue until the " freeze-up "; they have also been seen moving upstream after the ice has formed.

On July 27 another specimen was secured in the same net; its total length was 335; depth, 60; head, 56 mm. On August 5, when Charles Schweder took another specimen, of about the same size as the previous ones, from the same net in about 3 feet of water, he remarked that the species attains a weight of 2½ or 3 pounds, but that very few had ever been taken in their large-meshed nets. (Among all those that I saw, the maximum total length was perhaps 15-16 inches, and the maximum weight, perhaps scarcely a pound.) Once in October, he said, the bottom of Windy River was " just moving " with these fish. On August 29 Fred Schweder, Jr., reported seeing one in the edge of the river a quarter of a mile above its mouth; previously he had noticed these fish in the river only in October.

On the evening of October 10 Fred reported their return to this habitat as an apparently regular autumnal movement. With the help of an electric torch and a gas lantern, we observed a dozen or more of the Round Whitefish in the rocky shallows up to 1 foot deep, within a rod or so of the shore; the water was moderately clear, and the current moderate. They were pointing, and probably moving by degrees, upstream, though some seemed to remain in one spot for a time. There were three indications that the spawning season was at hand: roughened scales on the sides (as in the Common Whitefish at this season) in two out of three specimens examined for the purpose; flow of milt from one of the specimens handled; and ripe ova, about 2 mm. in diameter, in a specimen about 324 mm. in total length. Yet the fish appeared singly, not in pairs or groups. Five individuals were captured in a dipnet; two of them appear in figure 28.

On the evening of October 21 Fred Schweder, Jr., secured 13 additional individuals in the same place by striking them with an axe-handle. Two evenings later he reported " a lot " more there. It is interesting that the Round Whitefish migrates upstream at the spawning season, while the Common Whitefish is migrating downstream.

When one of the former was fried for lunch, the consensus of opinion among those partaking of it was that it made practically as good eating as the Common Whitefish. Those secured in previous years had been used merely for dog feed.

The stomach and intestine of a specimen (No. 540) taken on July 27, in Windy Bay just below the mouth of Windy River, contained the following small mollusks: *Valvata lewisi* Currier, 219 individuals and fragments; *Gyraulus arcticus* (Möller), 5 individuals. Another specimen (No. 566) from the same locality, August 5, similarly yielded 7 individuals of *Valvata lewisi* and 284 individuals and fragments of *Gyraulus arcticus* (Wurtz, 1948). These few records suggest that small mollusks constitute the principal food of the species.

Round Whitefish have been recorded (for the most part under the specific names of *quadrilaterale, cylindraceum,* or *preblei*) from the following localities in northwestern Canada: Fort Enterprise, Mackenzie (type locality of *Coregonus quadrilateralis* Richardson), Hudson Bay, and Churchill (Richardson, 1823: 714); " off the mouths of the Coppermine and Mackenzie, and in all the clear rivers and lakes north of the 62nd parallel," including Great Bear Lake (Richardson, 1836: 204); Fort Simpson (Kennicott, 1869: 207); Tazin River, Mackenzie, and Thluicho Lake, Saskatchewan (the former the type locality of *Coregonus preblei*) (Harper and Nichols, 1919: 266); Lake Athabaska (Kendall, 1924: 425; Rawson, 1947*b*: 75); Churchill, apparently in salt water (Dymond, 1933: 6; Vladykov, 1933: 48); Clinton-Colden and Baker lakes and Aberdeen River (Clarke, 1940: 116); Great Bear Lake, Rutledge River (tributary to Great Slave Lake), Baker Lake, Churchill, and Hudson Bay (Dymond, 1943: 198); Yukon River system (Wynne-Edwards, 1947*a*: 19); Great Bear Lake (Miller, 1947: 37, 41); and Great Slave Lake (Rawson, 1947*a*: 62). Evidently more than one species is represented in this vast region. Baker Lake and Aberdeen River are the only localities in Keewatin among those mentioned above.

Thymallus signifer (Richardson). Arctic Grayling. Figure 29.

This notable fish is a fairly common one in the Nueltin region, where it is found in both lakes and rivers. It began to be taken in small numbers in gill-nets in Windy Bay, off the mouth of Windy River, almost as soon as they were set in early July. Here the water was moderately clear; the depth varied from about 3 to 12 feet; and the bottom was rocky. My records for captures in the bay extend only from July 6 to July 10. The fish were caught in large-meshed as well as in small-meshed nets.

Later records were practically all from Windy River. An August 16 Fred Schweder, Jr., in commenting on the lack of recent captures in the bay, expressed the opinion that the fish were mostly in the rivers by that time. On July 20 children of the camp (Michael Schweder and Rita, the Eskimo girl) began to catch some larval fishes in the edge of the river, either by hand or in a cup. The same species, at increasing sizes, continued to be captured there at intervals until October. It was only after the individuals had passed the larval stage that they were recognized as Graylings. On July 26 I secured about a dozen specimens (then postlarval), for the most part with an insect net. They were very pale greenish above, with dusky punctulations, which were arranged chiefly in a double stripe on either side of the two dorsal fins; venter silvery white; caudal with some very minute punctulations; other fins perhaps plain. At the water level prevailing from July 20 to August 1, the edge of the river, where the little fishes were wriggling against a fairly good current, was grassy; the water was clear, up to 8 or 10 inches deep; the bottom was composed of rocks and sod. From August to October, when the water level was lower, the grass and sod were left behind, the bottom was rocky, and the current was easy. By August 12 parr marks had become evident on the young fishes. One or two that I observed on August 23 appeared about 2½ inches long and were well spotted. By resorting to the shallows of the river's margin, these little Graylings avoided not only the stronger midstream currents but most of the larger predatory fishes as well.

On July 22 an immature fish, about 5½ inches long, was found floating in a little bay on the river. Its anterior part seemed to be half digested, and I wondered if it could have been disgorged by one of two Red-throated Loons that had just departed from the place. There were three or four parr marks on the last couple of inches of the body. It was no doubt more than a year old.

On July 20 a fine adult, of average or slightly larger size, was observed as it swam up the river only 5 or 6 feet from the bank. It progressed close to the surface, and even broke the surface with its dorsal fin and perhaps part of its back as it passed over a submerged bunch of grass. By going close to the shore, it was obviously taking the easiest course up the swift river.

However, such a habit is not without its hazards from the Herring Gulls that are frequently seen perching on rocks in the river's edge. On August 2 Fred Schweder, Jr., reported such a bird plunging off its rock into the water, coming up with a squirming Grayling about a foot long, and making off with it.

The leaping proclivities of the Grayling were finely demonstrated in Windy River on several August evenings. On the 4th, for example, many of them cleared the water entirely—perhaps by half a foot. According to Fred Schweder, Jr., sunset is the most favored time of day for this activity. When he tried casting an artificial fly for the Graylings, he had no success. On the 29th, however, he secured one about a foot long on a hook baited with a blowfly. As this individual and one or two others were observed swimming in the edge of the river over a rocky bottom, where the water was perhaps a foot deep, I noticed that the long dorsal fin frequently bent or curved over to one side. At the fish camp, 2 miles up Windy River, I noted only one Grayling on October 2 among a catch of about 200 other fish (mainly Common Whitefish).

For an hour on the evening of October 10 our entire camp watched Graylings in the stony shallows of the river, with the help of electric torch and gas lantern. Though the surface of the river was rippled by the current, the species was readily identifiable by its big dorsal fin. Numbers of Round Whitefish were present at the same time. Among four Graylings scooped up with the dipnet and preserved, two were recorded as adult (fig. 29), one as subadult, and one as immature. The last was only 2 or 3 inches long—the only young fish of the year that had been noticed since August. One of the adults seen but not captured was larger than any previously observed. Those that actually came to hand during the season generally varied from about 11 to 16 inches in total length.

On this occasion Charles Schweder remarked on seeing half a dozen of the Graylings close together. This grouping, however, could scarcely have been behavior of the spawning season, which, according to all accounts, occurs in the spring. A male, 390 mm. in total length, had testes not especially well developed, and not flowing with milt. A 381-mm. female had fairly well-developed ovaries, with ova about 1 mm. in diameter. More than a century ago Richardson stated (1836: 191) that the roe was considerably developed toward the end of August. Clarke (1940: 120) has called attention to a run of Graylings along the shore of Baker Lake in August, when the stage of their egg development was comparable to that of the autumn-spawning Whitefish.

From the two above-mentioned adults of October 10 the following color description was drawn up the next morning: head dusky olive, with bluish and brassy reflections on cheeks; iris with a thin golden inner rim, a median zone of dusky, and an outer zone of greenish; dorsum dusky olive, margins of scales dusky; scales on sides with pale bluish and faint purplish centers; anterior sides with 25-40 black marks, Z- or Λ-shaped; venter silvery white, largely obscured by multitudinous dusky punctulations; dorsal fin dusky, with very pale bluish spots and with streaks (some greenish blue, some pale buffy); margin of dorsal pale purplish red; caudal dull purplish red, with a faint bluish tinge toward base; pectorals dusky, with a faint orange-buffy tinge; ventrals dark greenish, with bluish, pinkish, and buffy lengthwise stripes; anal greenish fuscous, with a pale reddish-orange mark or two at anterior apex.

During the evening of October 21 Fred Schweder, Jr., secured two adults and a young one (5 or 6 inches long) in the same place by striking them with an axe-handle.

Bryan McKay spoke of fishing for Graylings during the summer at Goose Creek, 10 miles south of Churchill. John Ingebrigtsen reported the species above tidewater in the Churchill and other rivers in that general area. Charles Schweder mentioned its occurrence in the upper Kazan River.

Among the localities where the Grayling has been recorded in the Canadian Northwest are the following: apparently Nueltin Lake or vicinity (Hearne, 1795: 71, as " toothed tittemeg "); " clear rivers to the northward of Great Slave Lake," including Winter River at Fort Enterprise (Richardson, 1823: 711, 714); Great Bear Lake (Richardson, 1836: 190); Great Slave Lake and Back's River (Back, 1836: 114, 157, 346); Anderson River (MacFarlane, 1890: 38); tributaries of lower Churchill River (Bell, 1880: 7C); Black or Stone (=Fond-du-Lac) River (J. B. Tyrrell, 1896: 14D); Dismal Lake (near Coppermine River) and Great Bear Lake (Hanbury, 1904: 217, 248, as "Arctic trout"); "throughout the region from Peace River and Athabaska Lake northward . . . to the Arctic Ocean " (Preble, 1908: 511); Horton and Dease rivers and Fort Providence (Anderson, 1913: 454); Reindeer Lake and Reindeer and Cochrane rivers (Buchanan, 1920:

98, 100); Lake Athabaska (Kendall, 1924: 433; Rawson, 1947*b*: 82); Great Slave Lake and Hanbury River (Critchell-Bullock, 1931: 34); vicinity of Churchill (Vladykov, 1933: 20); Hanbury River (Hornby, 1934: 109); Baker Lake (Pfaff, 1937: 7); Ptarmigan, Hanbury, and Thelon rivers and Aberdeen, Schultz, and Baker lakes (Clarke, 1940: 116, 120-122); Windy River (Downes, 1943: 249); Alsek and Yukon rivers (Wynne-Edwards, 1947*a*: 10, 14, 19); Mackenzie Basin (Wynne-Edwards, 1947*b*: 28); Great Bear Lake and Bear River (Miller, 1947: 37, 40); Great Slave Lake (Rawson, 1947*a*: 61). The Keewatin localities in the above list are Back's and Thelon rivers and Nueltin Lake (in part), Windy River, and Aberdeen, Schultz, and Baker lakes.

Mallotus villosus (Müller). Capelin.

John Ingebrigtsen spoke of the occurrence of Capelin in Hudson Bay, and of their occasionally entering Churchill River during storms. Dawson Inlet is one of the localities where he has found them. They are about 4 inches long. The stomachs of Arctic Charr are sometimes full of Capelin.

This species has been recorded from " the shores near Churchill River " (Hearne, 1795: 395); from Bathurst Inlet (Richardson, 1823: 710); from Roe's Welcome and near the mouth of Back's River (Richardson, 1836: 187); from Churchill (Walker, 1931: 473; Vladykov, 1933: 20); and from Lyon Inlet, Melville Peninsula (Pfaff, 1937: 7). Of these localities, Roe's Welcome and the mouth of Back's River are in Keewatin.

Catostomus sp. Gray Sucker.

Charles Schweder reports having taken a single " Gray Sucker " at the south end of Nueltin Lake, but none toward the north end. Joe Highway also reports this species in an unnamed lake along the upper course of Putahow River, on the Keewatin-Manitoba boundary. This is perhaps the species described by Harper and Nichols (1919: 263, pl. 15, fig. 1) as *Catostomus richardsoni*. This name has been relegated to the synonymy of *C. commersonii* (Lacepède) by Kendall (1924: 421, 422).

The " Gray Sucker " has been recorded from Cumberland House, Saskatchewan (Richardson, 1836: 113); Great Slave Lake, Mackenzie River, and Arctic Red River (Preble, 1908: 504); Lake Athabaska and Tazin, Taltson, and Salt rivers (Harper and Nichols, 1919: 263); Reindeer Lake (Buchanan, 1920: 98, as "Black Sucker"); Lake Athabaska and Athabaska Delta (Kendall, 1924: 422); Great Slave Lake (Rawson, 1947*a*: 62); and Lake Athabaska (Rawson, 1947*b*: 82). There are apparently no previous records from Keewatin.

Catostomus catostomus (Forster). Red Sucker. Figure 30.

This is apparently the only species of sucker harbored in the waters about the north end of Nueltin Lake, where it is common enough in the rivers as well as the lakes. It is disdained for the most part by the local residents, who utilize the ones taken in their nets merely for dog feed; and even the dogs do not seem to relish them particularly, in comparison with Whitefish and Lake Trout. The Red Suckers are distinctly edible, however, as I have found by experience when short of other fish or meat.

My first view of one in the Nueltin region was obtained on June 30. It was resting beside a rock, with little more than its head visible, in a pool at the side of Little River, a mile or so above its mouth. It was apparently close to 2 feet in length. The light orange-yellow of the under side of the head was conspicuous. On July 3 Anoteelik, the Eskimo boy, jumped into a rapid about 10 miles up Little River and secured six Red Suckers by poking them with a stick. They were said to be spawning right there; when disturbed and frightened away, they would return promptly. "The river was full of them."

Two days later I looked over several of these that had been brought for my inspection. Though somewhat dried up, they impressed me as more brilliantly colored than the Red Suckers I had observed in the Athabaska and Great Slave lakes region many years previously. The total length of one was 430 mm.; depth, 82; head, 96; snout, 49; eye, 13; pectoral, 79. Color: fuscous above; a broad reddish stripe from head to base of caudal along the lateral line, less distinct posteriorly, and about 24 mm. broad above pectoral; this stripe continued on head to eye, but perhaps somewhat orange; another stripe, fuscous and of approximately equal width, below the last, and continued on the head below the eye to the snout; lower side of head, including mouth, more or less light orange-yellow; venter silvery, washed with salmon; dorsal and caudal dusky, with perhaps a slight wash of salmon; pectorals, ventrals, and anal more or less dusky and more or less washed with salmon. The red lateral stripe may be distinctive of the males; yet the pearl organs were noted on individuals both with and without stripes.

On July 5 a male and a female (fig. 30) were brought from a small-meshed net in Windy Bay, off the river's mouth; the water was moderately clear, about 3 or 4 feet deep, and the bottom was rocky. The total length of the male was 465 mm.; to base of caudal, 390; depth, 90; head, 98; snout, 52; eye, 11.5. The dorsal two-thirds of its body was rather dark, and well marked off from the pale golden yellow of the lower sides; an obscure red lengthwise area along the lateral line, more pronounced anteriorly; chest and upper abdomen creamy white; pectorals, ventrals, and anal golden yellow, the paired fins with some dusky punctulations; pearl organs on ventrals, anal, and lower caudal. The testes were full and white with milt. The female was 440 mm. in total length; its general color was brassy yellow, darker dorsally; chest and upper abdomen creamy white. It exhibited no pearl organs. The numerous eggs in its ovaries were very tiny; presumably the fish was spent, or possibly it had not been in spawning condition that year.

A specimen about 13-14 inches in total length, taken in a small-meshed net on July 24, was said by Fred Schweder, Jr., to represent approximately a minimum size for those taken in the large-meshed nets. After it was immersed in alcohol overnight, its colors were noted as follows: dusky above; a broad, ill-defined reddish area along the lateral line from head to tail; head underneath, lower sides of body, and abdomen in front of ventrals, pale orange; chest, and mid-venter from ventrals to anal, white; fins all pale orange, more or less marked or washed with dusky.

Red Suckers continued to be brought from the nets as long as the latter were left in Windy Bay, up to September 25. During the latter part of the season the nets were placed in water up to 30 or 40 feet deep, with a mud bottom. One of the largest catches was made on August 11, after a two-day interval, when about 15 of these fish were secured in two nets, aggregating 150 yards in length.

On August 16, as I approached the rocky shore of Windy River in a canoe, a fish began floundering about in the shallows, and presently threw itself clear out on the shore, where I secured it. It was a fine, fat male Red Sucker, 483 mm. in total length (about the average size of those taken in the nets). Its feeble mind may have mistaken the canoe for a gigantic Lake Trout, from which it had to escape at any cost! An hour and a half after its capture its colors were noted as follows: whole dorsum, including top and sides of head, dusky olive or fuscous-olive, with brassy reflections and with a reddish tinge along the lateral line; midway between lateral line and ventral fin the color changing somewhat abruptly from fuscous to brassy (paler anteriorly, yellower posteriorly); this brassy or golden color extending across the venter in a broad band in front of the ventrals; rest of venter, from gills to anal and caudal, silvery white; labiae, with papillae, nearly colorless; ventro-lateral sides of head pale golden; gular region very pale orange; iris dusky, with some orange; dorsal fin dark olive; caudal likewise, with a slight reddish tinge on upper and lower rims; pectorals dark olive above, paler below; ventrals and anal dull orange, more dusky toward tip; a vestige of pearl organs on anal. The testes were much enlarged, with milt expressible. Nothing was found in the stomach.

In connection with the foregoing episode, Fred Schweder, Jr., informed me that in July, 1944, he had seen a Red Sucker flounder onto the shore of Windy River when pursued by a 20-pound Lake Trout. He had seen the same thing happen on two other occasions, when no pursuing fish was observed. The Suckers remain on shore only a few seconds, he added, before they get back into the water.

On July 14 three individuals, about 16-17 inches in length, were taken in a small-meshed net in Josie's Bay, a westerly arm of Windy Bay. Although a hasty dissection indicated that all were males, none had pearl organs on the fins, and only one was faintly marked with red on the sides. All proved a satisfactory addition to our temporarily meager rations.

At the fish camp on Windy River, 2 miles above its mouth, there were four Red Suckers in a catch of about 85 fish on September 25, and two in a catch of approximately 200 on October 2. Although the latter were presumably not due to spawn till the next spring, they had larger ovaries and larger ova (say 1 mm. in diameter) than a Common Whitefish 17 inches in length.

An individual from Windy Bay, July 19, was about 21 inches in total length, and the largest one of which I made a definite note during the season. Two individuals captured there on September 10 weighed 3¼ and 4 pounds—perhaps a little more than the average weight of those that came to net. One from Windy River, September 25, was 480 mm. in total length and weighed 2¾ pounds.

In a spruce thicket by Little River, on August 26, I found the bones of what appeared to be a Red Sucker; they had probably been left there by some predator, such as a Mink.

Charles Schweder remarked to me on the scarcity of fish in Red River, which joins Windy River from the west a mile or so above Simons' Lake. It is composed of coffee-colored muskeg water, and few fish enter it except Red Suckers on their spawning migration in the spring. They are not known to occur above the falls a couple of miles from the river's mouth. A few Common Whitefish and Lake Trout follow the Suckers in the spring to feed upon their spawn. Charles has not observed Suckers in the Kazan River or in the Little Dubawnt River.

Joe Highway reports the present species in an unnamed lake along the upper course of Putahow River, on the Keewatin-Manitoba boundary.

Some of the localities in northwestern Canada from which the Red Sucker has been recorded are the following: streams about Hudson Bay (Forster, 1773: 155); Kazan ("Cathawhachaga") River, apparently Nueltin Lake or vicinity, and Great Slave Lake (Hearne, 1795: 36, 71, 249, as "barble"); Great Slave Lake (Richardson, 1836: 116; Rawson, 1947*a*: 62);

Coppermine River (Simpson, 1843: 267); Anderson River (MacFarlane, 1890: 38, as " carp "); Artillery Lake (J. W. Tyrrell, 1924: 20); Hanbury River (Hanbury, 1904: 41); Hayes River (Evermann and Goldsborough, 1907: 93); Great Bear Lake and Mackenzie River (Preble, 1908: 503); Mackenzie Delta (Anderson, 1913: 451); Reindeer Lake and Cochrane River (Buchanan, 1920: 101); Rivière Coupée and Lake Athabaska (Kendall, 1924: 421); Churchill (Vladykov, 1933: 21); Artillery Lake and Hanbury River (Critchell-Bullock, 1931: 33; Hornby, 1934: 109); Windy River (Downes, 1943: 249); Great Bear Lake (Miller, 1947: 37, 41); and Lake Athabaska (Rawson, 1947*b*: 82). Of the localities mentioned above, only Nueltin Lake (in part) and the Kazan and Windy rivers lie in Keewatin.

Esox estor Le Sueur. American Pike; Northern Pike. Figure 31.

In the Nueltin Lake region, as in northwestern Canada generally, the present species is nearly always referred to as " Jackfish."

The Pike, while both a lake and a river fish, seems to be mainly a shallow-water form. On June 30, while walking for half a mile along the margin of Little River, I startled numerous rather small fishes in the grassy shallows, but saw little of them except their swift wakes as they made for deeper water. One, however, was distinctly seen to be a young Pike about 5 inches long; and probably most of the others were of the same species.

On July 1 several large Pike were observed, and two were taken in a 12-foot seine, in Duck Bay, between the mouths of Windy and Little rivers. The seine was dragged chiefly in grassy shallows less than 2 feet deep, either along the bay shore or in the mouth of a little boggy inlet. Both individuals were spent females, respectively 1084 and 815 mm. in total length and weighing 13 and 6¾ pounds. A few ova, about 2 mm. in diameter, were left in the ovaries of the larger specimen. The stomachs of both contained yellowish mucus; the smaller one contained also a partly digested Round Whitefish 240 mm. in length to base of the caudal. These two Pike had been sluggish enough to be captured with surprising ease. The spots on their sides (fig. 31) appear relatively smaller or narrower than in two specimens from Lake Athabaska (Rawson, 1947*b*: 81, fig. 20), and less inclined to coalesce in the form of oblique or transverse bars on the lower sides and the caudal peduncle. In these respects three that I photographed in 1914 at Tsalwor Lake, in the Tazin River drainage system a few miles north of Lake Athabaska, resemble the Athabaska specimens.

Another Pike was apparently taken in a gill-net on July 6 near the entrance to Duck Bay. On July 28 Fred Schweder, Jr., caught a 29- or 30-inch individual on a spoon hook in Windy River. On August 3 Michael Schweder used a dipnet to capture a 48-mm. specimen in the stony shallows along the edge of Windy River. After a night in alcohol, this young Pike showed a pale orange suffusion on the proximal half of the caudal, and a faint indication of the same color on the basal half of the dorsal; iris somewhat golden above, silvery below; ground color of sides straw color. On August 16 one Pike, and on September 25 two more, were brought from a gill-net in Windy Bay; the net on the latter date, at least, was placed in water 30-40 feet deep, with a mud bottom. On September 11 I noted an individual about 4 inches long in a sandy cove on Windy Bay; it was presumably not many weeks old. On September 25 there was a single Pike, 700 mm. in total length and weighing 5½ pounds, in a catch of about 85 fish on Windy River 2 miles above its mouth; and on October 2 there was another in a similar catch of about 200 fish. At Simons' Lake in October there were a couple of dead Pike lying on the shore.

The Pike is not ordinarily eaten by the residents when Whitefish, Lake Trout, or Graylings are available. The numerous bones make it less desirable than the others, although its flesh is very palatable.

Three of the adult Pike taken during the season were examined for gill parasites, but without result.

Bryan McKay reported this species at Goose Creek, 10 miles south of Churchill. John Ingebrigtsen spoke of its general occurrence in rivers in the vicinity of Churchill, and of its attaining a length of 3½ to 4 feet. Charles Schweder reported it in the upper Kazan River; and Joe Highway, in an unnamed lake along the upper course of Putahow River on the Keewatin-Manitoba boundary.

The Pike has been recorded from numerous localities in northwestern Canada, including the following: "in all the lakes" about Hudson Bay (Pennant, 1792: ccxcix); "Shee-than-nee" (Tadoule?) Lake, Manitoba, apparently Nueltin Lake or vicinity, and Great Slave Lake (Hearne, 1795: 16, 71, 249); "every piece of fresh water up to the Arctic extremity of the continent" (Richardson, 1836: 124); Anderson River (MacFarlane, 1890: 38); Dubawnt or Kazan rivers (J. B. Tyrrell, 1897: 164F); Artillery Lake (J. W. Tyrrell, 1924: 20); Saskatchewan River (Evermann and Goldsborough, 1907: 105); "practically all the waters of the [Athabaska-Mackenzie] region"; "not found in the Ark-i-linik, Great Fish, or Coppermine rivers, but . . . an inhabitant of the Anderson" (Preble, 1908: 513); lakes and rivers east to Coronation Gulf (Anderson, 1913: 454); Reindeer Lake (Buchanan, 1920: 98, 101; Downes, 1943: 66); Lake Athabaska (Kendall, 1924: 436; Rawson, 1947*b*: 80); Churchill (Walker, 1931; Vladykov, 1933: 21); Thelon River (Clarke, 1940: 117); South Knife Lake, Manitoba (Downes, 1943: 280); Yukon River system (Wynne-Edwards, 1947*a*: 20); "throughout the Mackenzie lowlands to the delta" (Wynne-Edwards, 1947*b*: 29); Great Bear Lake (Miller, 1947: 41); and Great Slave Lake (Rawson, 1947*a*: 62). Of the above-mentioned localities, Nueltin Lake and the Dubawnt and Thelon rivers (in part) and the Kazan River lie in Keewatin.

?Boreogadus saida (Lepechin)

A "Rock Cod" mentioned by John Ingebrigtsen may be this species. He described it as having a black peritoneum (*cf.* Jordan and Evermann, 1898: 2533) and a deeper and fuller belly than the Atlantic Cod. He has taken it at Dawson Inlet, Keewatin, along with Arctic Charr, in nets with a mesh of approximately 5½ inches, although some of the Rock Cod slip through a mesh of this size. Some of them weigh from 1 to 2½ pounds. The largest he has taken was 24 inches in length.

Vladykov (1933: 38) records this species from Churchill and from various stations in offshore waters of Hudson Bay, extending from the vicinity of York Factory to Coats and Mansel islands.

Lota maculosa (Le Sueur). Burbot; "Moray." Figure 32.

This species, which goes by the local name of "Moray," appears to be quite uncommon in the Nueltin Lake region.

Among some fish brought down to the base camp on July 24 from a net 2 miles up the Windy River, I noticed a much digested, half-skeletonized Moray about a foot long. Fred Schweder, Jr., informed me that it had been taken from the stomach of a 20-pound Lake Trout netted two days previously.

On August 9 I happened to step on a large stone lying in the edge of Windy River a quarter of a mile above its mouth and projecting a little above the surface in 6-8 inches of water. As it rocked under my weight, a Moray approximately 290 mm. in total length squirmed out from beneath it and came to rest between some other rocks a yard away. I dashed for the cabin, returned with a shotgun, and secured the specimen with an "aux" shell. Fred Schweder, Jr., though very familiar with the local fishes and their ways, had never noticed a Moray lurking beneath rocks. The specimen was olive-green, obscurely mottled with darker spots; throat and abdomen dirty white, with dusky punctulations; fins essentially the color of the body; iris pale golden.

On September 16 Charles Schweder brought a specimen (fig. 32) from a net placed in 30-40 feet of water in Windy Bay, over a mud bottom. It was 696 mm. in total length and about 4 pounds in weight. After being left in a canoe all night, with perhaps half an inch of water, it was still alive the next morning. Its fins were tinged with reddish. There was nothing in its stomach. An approximately 12-inch Moray was found in the stomach of a 19.5-pound Lake Trout, taken on October 22 in the Windy River 2 miles above its mouth.

During the evening of October 10 Fred Schweder, Jr., observed a small individual in the rocky shallows of Windy River near the base camp. On December 1 he found a Moray a little more than a foot long on the ice bordering the open water of Crooked Rapid, ¾ mile above the mouth of this river, where it had been left by a Mink. The left side of its jaw was broken through, and there were some small tooth marks on its head. It was well spotted and mottled. The exterior of the fish was a mass of slime, apparently sufficient to discourage the Mink from feeding on it. On two other occasions, in previous winters, the collector had noticed a similarly disdained Moray at the same place. Charles Schweder has never known a dog to eat one of these fish. Richardson gave similar testimony over a century ago (1836: 248).

Fred Schweder, Jr., reported that two specimens, about 2 feet long, had been taken at the mouth of Windy River in October, 1946. Previously Charles Schweder had caught one on a hook near the narrows on Windy Bay; it was said to have weighed at least 10 pounds. Charles also reported catching three individuals in the fall of 1946 in the Little Dubawnt River, which flows into the south end of Dubawnt Lake.

Other localities in northwestern Canada from which the Burbot has been recorded include: Hudson Bay (Forster, 1773: 152); " in the rivers " about Hudson Bay (Pennant, 1792: ccxcvii); vicinity of " Shee-than-nee " (Tadoule?) Lake, Manitoba, apparently Nueltin Lake or vicinity, and Great Slave Lake (Hearne, 1795: 16, 71, 249, as " burbut " or " methy "); " every river and lake from Canada to the northern extremity of the continent," including Pine Island Lake, Saskatchewan (Richardson, 1836: 248); near the mouths of the Mackenzie and Coppermine rivers (Simpson, 1843: 111, 267); Mackenzie Basin (Kennicott, 1869: 208); Anderson River (MacFarlane, 1890: 38); " nearly every lake and stream throughout the Mackenzie region," including Arctic Red River and the junction of the Liard and Mackenzie rivers, " and also . . . the Arctic Ocean " (Preble, 1908: 514); Horton River, where it is " a favorite food fish of the Eskimo " (Anderson, 1913: 455); Churchill (Vladykov, 1933: 42); Thelon River (Clarke, 1940: 117); Mackenzie River system (Wynne-Edwards, 1947*b*: 29); Great Bear Lake (Miller, 1947: 41); Great Slave Lake (Rawson, 1947*a*: 62); and Lake Athabaska (Rawson, 1947*b*: 82). Of the above-mentioned localities, Nueltin Lake and the Thelon River lie partly in Keewatin.

Pungitius pungitius (Linnaeus). Nine-spined Stickleback.

In the Nueltin Lake region this species does not seem to occur in the abundance that one finds in the Mackenzie Basin. Only a few specimens were noted in the lake, and none in the rivers.

One was seined on July 1 in Duck Bay, in grassy shallows with moderately clear water. On July 12 a number were seen, including four that were captured with a dipnet, in a rocky cove of Josie's Bay; the clear water was 1 to 2 feet deep, and some grass was growing in it. After the specimens had been preserved in alcohol overnight, the following color notes were made, particularly on the largest one, 37 mm. in total length: about seven crossbars from pectoral to caudal, the first two nearly square, the rest narrow; whole body, except lower side of head and the venter (which are silvery white), finely speckled with dusky; dorsal spines and rays with punctulations; also punctulations on pectorals and caudal, those at the base of the latter so thick as to form a blotch; distal portion of caudal very faintly orange; ventrals and anal plain.

On August 19 about seven Sticklebacks were found in the proventriculus of an adult American Merganser, taken the previous day in a gill-net set in 30-40 feet of water in Windy Bay; one of them was preserved. Thus the spines of this species do not protect it from attack by the Merganser or by various large fishes, such as Inconnu, Pike, Pike-perch, Goldeye, and Burbot (*cf.* Rawson, 1947*a*: 60, 62, and 1947*b*: 79, 80, 82).

Other localities in northwestern Canada from which the Nine-spined Stickleback has been recorded include the following: Cumberland House, Saskatchewan (Richardson, 1823: 728); Great Bear Lake or vicinity (Richardson, 1836: 57; Preble, 1908: 513; Miller, 1947: 37, 42); Fort Resolution and Peel River (Kennicott, 1869: 171, 208); mouth of Nelson River (Bean, 1881: 128); Lake Athabaska and Athabaska Delta (Kendall, 1924: 437); Southampton Island (Henn, 1932: 3); Churchill (Vladykov, 1933: 23); Chesterfield Inlet (Pfaff, 1937: 7); Baker Lake (Pfaff, 1937: 7; Clarke, 1940: 117); Great Slave Lake (Rawson, 1947*a*: 60, 62); and Lake Athabaska (Rawson, 1947*b*: 79, 80, 82). Of these localities, Southampton Island, Chesterfield Inlet, and Baker Lake are in Keewatin.

Cottus cognatus Richardson. Great Bear Lake Sculpin. Figure 33.

This Sculpin was numerous in the grassy and stony shallows of Windy River a quarter of a mile above its mouth, where 32 specimens were collected between July 9 and August 19. Though probably widely distributed in the Nueltin Lake region, it was detected in only one other place.

The first one was noted moving by a rock where I was in the habit of dipping up buckets of water. I then took a dipnet and scooped with it blindly in the river's grassy margin, thus securing five specimens in the course of half an hour. The water was clear, with a depth up to a foot, a strong current, and a rock and sod bottom. All the specimens were mottled, and they exhibited a pronounced caudal bar. On July 24, in the evening twilight, three more were taken with a seine in the same area. The largest was about 60 mm. in total length.

On August 3 Fred Schweder, Jr., secured 22 specimens with a dipnet in the same part of the river. They had evidently been lurking beside or beneath the stones of the river's bottom. By that date the water level had dropped somewhat, the margin was less grassy, and the current was easier. Two of the specimens were distinctly larger than any I had ever found in the Athabaska and Great Slave lakes region; the larger one (fig. 33) was approximately 90 mm. in total length. After immersion overnight in alcohol, these two exhibited a pale orange border on the first dorsal; and there was a fair indication of the same coloration in some of the smaller specimens. The two final specimens were collected at the same place on August 19 by Rita, the Eskimo girl. On September 11 an approximately 2-inch individual was seen inching along the sandy bottom of a cove on Windy Bay, where the water was quite clear.

In previous years Fred Schweder, Jr., would see these fishes lying on the bottom or going under rocks near the edge of Windy River. He would occasionally catch one by hand and let it go. He had never noted any in the stomachs of larger fishes.

Previous records from northwestern Canada are not numerous. Among them are the following: Great Bear Lake (Richardson, 1836: 40; Miller, 1947: 37); Lake Athabaska (Kendall, 1924: 437; Rawson 1947*b*: 75, as "cottids"); Hanbury River (Critchell-Bullock, 1931: 34); Baker Lake (Pfaff, 1937: 13); Hanbury and Lockhart rivers and Heuss Lake (Clarke, 1940: 117); and Great Slave Lake (Clarke, 1940: 117; Rawson, 1947*a*: 55, 58, 60, 62, as "cottids"). Of these localities, only Baker Lake is in Keewatin.

The foregoing account includes apparently all the freshwater fishes hitherto known from Keewatin. In fact, only three previous scientific collections of freshwater species in the entire district of Keewatin have been reported on, as far as I am aware. These were made by the Fifth Thule Expedition of 1921-24 on the mainland (Pfaff, 1937); by George M. Sutton on Southampton Island in 1929-30 (Henn, 1932); and by C. H. D. Clarke (1940) from the Thelon River to Baker Lake in 1937.

The remaining fishes known from Keewatin are maritime. A list of these, with the localities in this district or its offshore waters from which they have been recorded, follows.

Eleginus nawaga (Kölreuter). Wachna Cod.
Simpson Strait? (locality not certain) (Pfaff, 1937: 12).
Icelus bicornis (Reinhardt).
Chesterfield Inlet (Pfaff, 1937: 12).
Acanthocottus scorpioides (Fabricius). Arctic Sculpin.
Roe's Welcome and Chesterfield Inlet (Pfaff, 1937: 13).

Acanthocottus groenlandicus (Cuvier and Valenciennes). Daddy Sculpin.
Roe's Welcome and Chesterfield Inlet (Pfaff, 1937: 14).

Oncocottus quadricornis (Linnaeus).
Chesterfield Inlet (Pfaff, 1937: 15).

Oncocottus hexacornis (Richardson).
Coral Inlet, Southampton Island (Henn, 1932: 3).

Gymnocanthus tricuspis tricuspis (Reinhardt).
Whale Point, Roe's Welcome (Pfaff, 1937: 16).

Eumicrotremus spinosus (Müller). Spinous Lumpfish.
Roe's Welcome (Pfaff, 1937: 16).

Eumicrotremus derjugini Popov.
Off Coats Island (Vladykov, 1933: 34).

Ammodytes dubius hudsonius Vladykov. Hudson Bay Sand Lance.
Off Eskimo Point (Vladykov, 1933: 23); Eskimo Point (Pfaff, 1937: 10).

Stichaeus punctatus (Fabricius). Spotted Snake Blenny.
Off coast of southern Keewatin (Vladykov, 1933: 23).

Lumpenus fabricii (Cuvier and Valenciennes).
Near Eskimo Point (Evermann and Goldsborough, 1907: 111); northwestern Hudson Bay (Vladykov, 1933: 35).

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EXPLANATION OF PLATES

PLATE 10

Fig. 26.—Lake Trout (*Cristivomer namaycush*); total length, 1010 mm.; weight, 20½ pounds. Windy Bay, Nueltin Lake, July 5, 1947.

Fig. 27.—Manitoba Whitefish (*Coregonus atikameg manitobensis*); total lengths, 623 mm. (upper) and 640 mm. (lower); weights, 6½ and 6 pounds. Windy River, September 25, 1947.

Fig. 28.—Hearne's Round Whitefish (*Prosopium hearnei*): paratype (no. 585, upper) and type (no. 586, lower); total lengths, 330 and 353 mm. Windy River, October 10, 1947.

Fig. 29.—Arctic Grayling (*Thymallus signifer*), no. 582; total length, about 410 mm. Windy River, October 10, 1947.

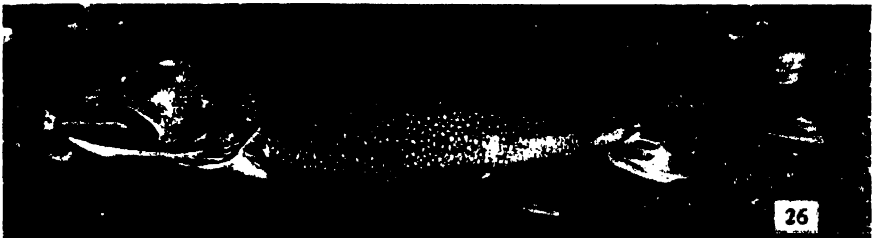
PLATE 11

Fig. 30.—Red Suckers (*Catostomus catostomus*); total lengths, 440 mm. (female, upper) and 465 mm. (male, no. 520, lower). Windy Bay, Nueltin Lake, July 5, 1947.

Fig. 31.—American Pike (*Esox estor*), females; total lengths, 815 mm. (upper) and 1084 mm. (no. 517, lower); weights, 6¾ and 13 pounds. Duck Bay, Nueltin Lake, July 1, 1947.

Fig. 32.—Burbot (*Lota maculosa*), no. 579; total length, 696 mm.; weight, about 4 pounds. Windy Bay, Nueltin Lake, September 16, 1947.

Fig. 33.—Great Bear Lake Sculpin (*Cottus cognatus*), no. 543; total length, about 90 mm. Windy River, August 3, 1947.



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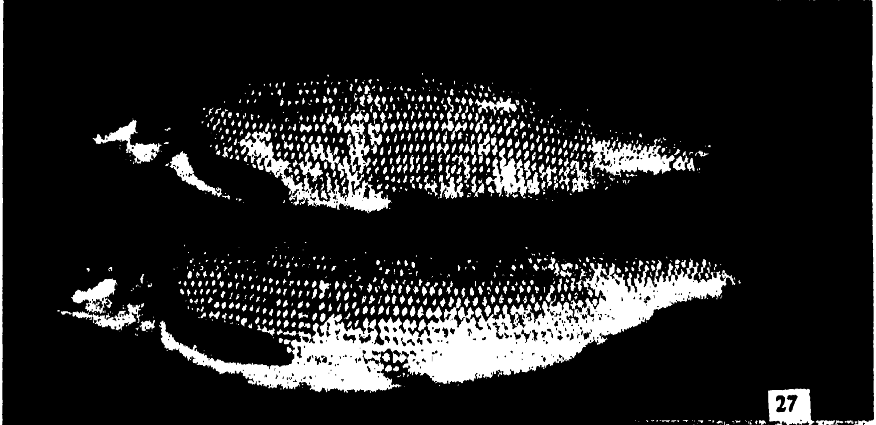

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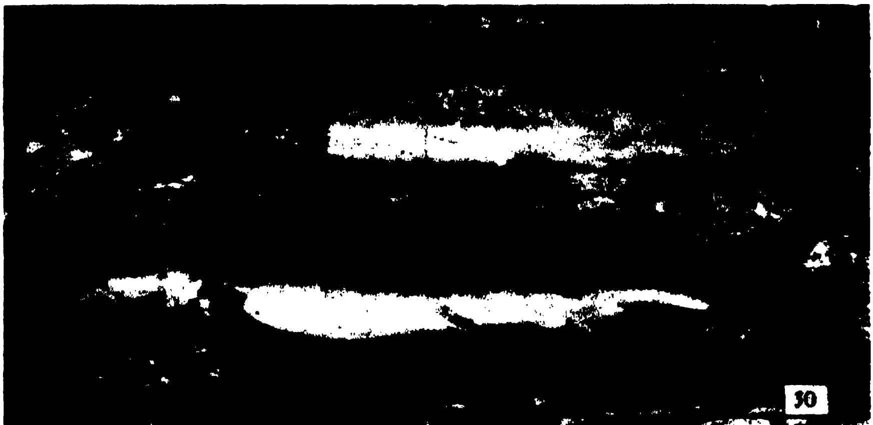
FOWLER AND HARPER: KEEWATIN FISHES



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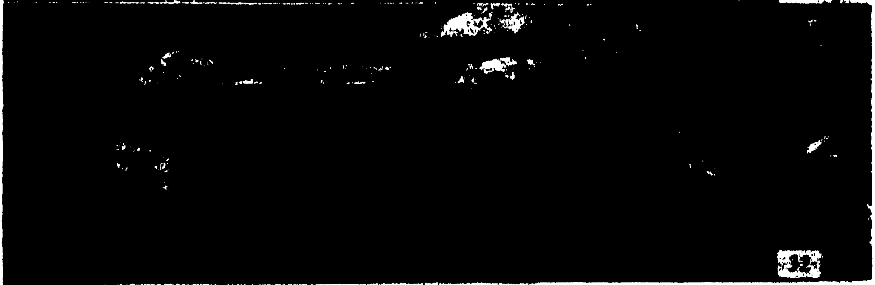

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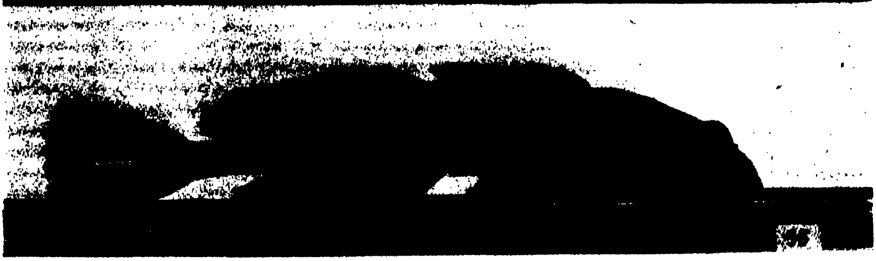

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FOWLER AND HARPER: KEEWATIN FISHES

INLAND MOLLUSKS OF NORTHERN MEXICO.—I. THE GENERA HUMBOLDTIANA, SONORELLA, OREOHELIX AND ASHMUNELLA

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During the summer months of 1934 and 1935 Dr. Francis W. Pennell and the author, ably assisted by Mr. Cyril H. Harvey, collected mollusks and plants in northern Mexico. This work was efficiently aided by grants from the American Philosophical Society.

The report on molluscan material collected has been delayed by work on another project now completed; but certain genera are published here in advance of the final report, for the convenience of zoologists having material from the same region.

Heights were determined by aneroid barometer which was checked wherever known elevations were available, but no other correction made.

HUMBOLDTIANA Von Ihering

The species of this genus and their anatomy have been discussed, so far as material was available, in a former paper.[1] Those obtained in the Sierra Madre Oriental and outlying mountains in the states of Nuevo Leon, Coahuila and Zacatecas add materially to knowledge of the internal structure of the penis and the dart apparatus. Notes on *H. högeana* (Martens), the widely distributed species of the state of Chihuahua, will be given later, with figures.

The generitype of *Humboldtiana* was given by Von Ihering as "*Helix humboldtiana* Val." We take this to be "*Helix humboldtiana* Valenc." of Pfeiffer, 1841,[2] although what little Von Ihering knew of the anatomy was from W. G. Binney's account of a species now known as *Humboldtiana potosiana;* cf. Zeits. Wiss. Zool., 54: 461, and these Proceedings, 79: 167, 178. *H. humboldtiana* (Pfr.) has not been dissected.

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[1] The structure and affinities of *Humboldtiana* and related helicid genera of Mexico and Texas. Proc. Acad. Nat. Sci. Phila., 79, pp. 165-192, 1927.

[2] Deshayes in 1851 described a different species as "*Helix humboldtiana* Valenciennes," stating that Pfeiffer had applied that name to a species different from the shell which had been given the ms. name *H. humboldtiana* by Valenciennes in the Paris Museum. Unfortunately this unlawful change was followed by Von Martens in the Biologia Centrali-Americana, p. 147 (1892), where the prior *H. humboldtiana* of Pfeiffer was renamed var. *hegewischi.* The form described by Deshayes, if valid and distinct from *H. buffoniana,* will require a new name, but this can be taken up when it is rediscovered.

The generic definition of *Humboldtiana* requires several alterations, as in some species there is no proper verge. The typical number of four dart sacs is sometimes reduced to two or to one, the missing sacs being represented by small vestiges or wholly absent. Variation in the number of dart sacs is not wholly unexpected, as in several species with four sacs, figured in my paper of 1927, the sacs are of unequal size, some being conspicuously smaller than others.

The penis in *Humboldtiana* has a small chamber at the apex (fig. 3 b, upper cavity), with which the epiphallus communicates by a pore having a star-shaped corrugation around it as in Pl. 14, fig. 1 at right, and fig. 2 a′. This chamber is separated from the cavity of the penis by a partition which has an opening, or is produced in a verge, whereby there is communication with the penis cavity below. This is an unique structure. Is the apical chamber to be regarded as an upper part of the verge cavity, the partition being a modification of the verge? So it seems. When there is no proper verge the orifice in the partition has a four- or five-lobed border, as in fig. 2 a. When a verge is developed it has a large cavity with folded walls and the opening at the end is large and lobed (as in fig. 3 b, and in these Proceedings for 1927, plate 13, fig. 4a).

The wall of the penis cavity has a series of longitudinal ribs (fig. 2 b) or a few large, irregular fleshy processes (as in Pl. 14, fig. 1, showing the interior of the penis from above, the partition removed). Also figs. 2 a, 3 b, the penis opened lengthwise.

This structure of the penis is probably common to all humboldtianas, specific divergence being chiefly in the size of the apical chamber, the degree of development of the verge and the size and conformation of the fleshy ribs or processes of the penial wall.

The anatomic structure of *H. torreana* Pilsbry (these Proceedings, 87: 1, 1935) is unknown. That species is characterized by the total absence of granulation of the shell, as in *H. fortis.*

Humboldtiana montezuma Pilsbry Plate 12, figs. 1, 2.

Humboldtiana montezuma Pilsbry, 1940, Nautilus, 53: 140.

The shell is rather thin, narrowly, partly covered umbilicate, somewhat depressed globose; vinaceous-brown or rood's brown (of Ridgway) with a profusion of white striae. The apical 1½ whorls are smooth, whitish, later whorls striate along lines of growth, the last whorl having close but unequal thread-like white striae about as wide as their dark intervals, but unequally spaced, and with many small granules between and on the edges of most striae. The last whorl descends slowly and moderately in front. The suture is rather strongly impressed. The large aperture is moderately oblique, rotund; glossy sorghum brown varying to somewhat paler tints within, the thin lip being narrowly edged with white. The basal margin of the white lip expands slightly; columellar margin is rather broadly reflected towards the insertion, concealing the umbilicus in a basal view.

Height 43.7 mm., diameter 49.7 mm., aperture 35 × 33.5 mm.; 4½ whorls. Type, Pl. 12, fig. 1.

Height 47.5 mm., diameter 51.4 mm. Paratype, Pl. 12, fig. 2.

Nuevo Leon: Summit of El Infiernillo, a mountain near Pablillo, Municipio de Galeana, at 10,100 ft. Type and paratype 164062 ANSP., collected by Pennell, Harvey and the author.

Genitalia of the type specimen (fig. 1, posterior part omitted), show that the species belongs to the series having the mucous glands crowded close above the dart sacs, of which four are about equally well developed. The spermathecal duct arises close above the mucous glands, and about 33 mm. from the end it bears a rather long branch. The cylindric penis contains a short thick and blunt verge, the cavity of which has four large ridges (seen in section in fig. 1 a); the outer wall of the penis being weakly and distantly ribbed within; below the verge the penial walls become very thick,

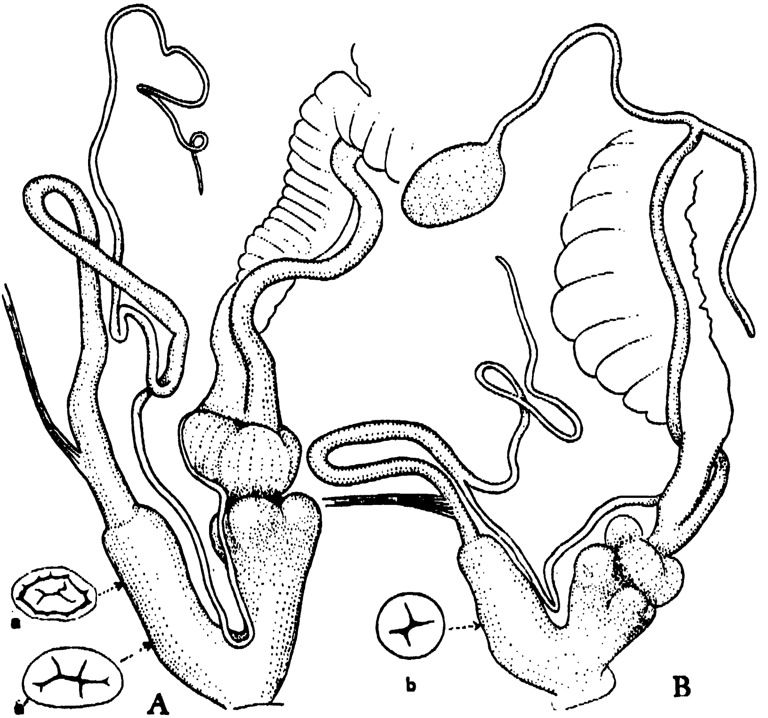


Fig. 1.—A, *Humboldtiana montezuma*, anterior parts of genitalia of the type; a, section of penis showing verge; a', section farther forward. B, *H. m. inferior*, genitalia of paratype; b, section of penis below verge.

by having four or five heavy ridges, shown in section in fig. 1 a′, which practically fill the cavity. The penial retractor is inserted on the epiphallus. The epiphallus is nearly three times the length of the penis. Flagellum of medium length, about equal to penis and epiphallus together. Measurements follow:

Penis	11 mm.	Flagellum	40 mm.
Verge	3 mm.	Vagina + atrium	18 mm.
Penial retractor	25 mm.	Spermatheca and duct	71 mm.
Epiphallus	32 mm.	Diverticulum of same	23 mm.

The large size of the shell, with sculpture of thread-like white striae on a dark ground characterize this species.

There is a fairly good trail up El Infiernillo and one rides to the summit, which is stony, with dwarf scrub oak and a few scattered pines. On reaching the summit a heavy hail storm made the horses unruly and we had time to gather but a few of the magnificent humboldtianas, which were found on limestone outcrops. *Euglandina, Mesomphix, Epirobia* and a few other snails were taken there. Search on a level area about 500 feet lower did not produce any *Humboldtiana,* which appears to be confined to the summit.

Humboldtiana montezuma inferior new subspecies Plate 12, figs. 3-8.

The shell is smaller than *H. montezuma,* but like that in sculpture. It is similar in color except that there are three walnut-brown bands, and the ground color is often lighter.

Height 37 mm., diameter 38.5 mm.; 4½ whorls. Type, Pl. 12, fig. 4.
Height 29 mm., diameter 30.5 mm.; 4⅓ whorls, Pl. 12, fig. 7.

NUEVO LEON: about three kilom. from Hacienda Encinal, near Pablillo, Municipio de Galeana, on the trail to Alamar, among scattered oaks on a red clay soil; elevation estimated as about 6000 ft. or somewhat lower. Type and figured paratypes 164043 ANSP., collected by the author.

The oblong penis is similar to that of *H. montezuma* in internal structure. The section, fig. 1 b, represents the part occupied by thick, high longitudinal processes. The epiphallus is nearly double the length of the penis and the penial retractor is inserted on it near the penis. The flagellum is about as long as the penis and epiphallus together. The vagina is relatively very short and bears four subequal dart sacs. The mucous glands project prominently close above the dart sacs. The spermatheca is oval, on a relatively short duct, which branches in a rather long diverticulum. Organs of the figured specimen (fig. 1 B) measure in length:

Penis	8 mm.	Flagellum	25 mm.
Penial retractor	20 mm.	Spermatheca and duct	52 mm.
Epiphallus	15 mm.	Diverticulum of same	11 mm.

The anatomic differences between this and *H. montezuma* are inconsiderable but in *H. m. inferior* the epiphallus is relatively, as well as actually, decidedly shorter and the diverticulum of the spermathecal duct is much longer.

Humboldtiana chrysogona new species Plate 14, fig. c; text-fig. 2B.

The shell is thin, obliquely umbilicate, somewhat depressed globose, with low conic spire. The first 1½ whorls are smooth and glossy, the rest obliquely striate and after the second whorl having low irregularly spaced wrinkles and a dense, distinct granulation, which fades out around the umbilicus. The ground color of light ecru-olive is largely replaced by cream white in streaks and on wrinkles and granules. There are three chestnut-brown bands, irregularly interrupted. The last whorl descends in front to the lower band. The aperture is rather strongly oblique, its width nearly equal to the length, showing the bands within. Peristome thin, shortly and rather widely reflected at the columellar insertion, at least three-fourths covering the narrow umbilicus.

Height 24.5 mm., diameter 26.5 mm., aperture 18 × 17 mm.; 4½ whorls.

ZACATECAS: Concepción del Oro, on a low limestone bluff at lower border of the village Aranzazu, elevation 8500 feet. Type and two paratypes 164055 ANSP., collected by the author July 19, 1934. Also found above that locality, on the trail up Temeroso at about 9500 feet (164067 ANSP.).

The genitalia of the type are drawn in fig. 2 B. The somewhat cylindric penis contains a short, broad verge, below which the walls have four strong lengthwise ridges (fig. 2 b). The partition bearing the verge is not shown in the figure. Epiphallus is very long, about 2½ times the length of penis; the penial retractor being attached between the anterior fourth and third of the length of epiphallus. The flagellum is about as long as the epiphallus. There is a single large dart sac, with barely discernible traces of one or two others (in the type, but not seen in a paratype). The mucous glands form about three-fourths of a ring, with a break on the side opposite the dart sac. The spermathecal duct, at about three-fourths of its length, bears an extremely short (1 mm.) diverticulum. Measurements of length follow:

Penis	9 mm.	Flagellum	24 mm.
Verge	2 mm.	Spermatheca and duct	40 mm.
Epiphallus	23 mm.	Diverticulum of same	1 mm.

This snail is so much like *H. nuevoleonis* in miniature that before dissecting I had referred it to that species as a small race. However, it is clearly distinct by the following characters: (1) The reduction of the dart apparatus to a single large dart sac and mucous glands which form only about three-fourths of a ring, being entirely interrupted on the side opposite the dart sac. (2) The greatly reduced branch of the spermathecal duct. (3) The longer epiphallus, with the retractor muscle situated farther back upon it than in any other known species; and finally, (4) the different conformation of the interior walls of the penis.

The anatomic peculiarities were found to be practically identical in two examples examined. The small size of the shell and its copious light streaks, irregularly interrupting the bands, are further attributes of *H. chrysogona*.

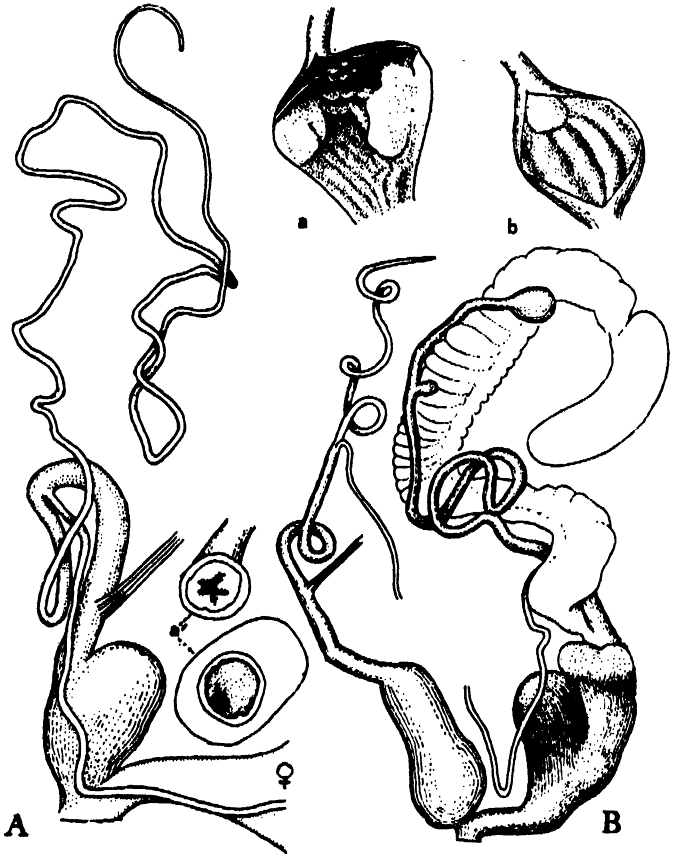


Fig. 2.—A, Male end organs of *Humboldtiana fortis*, type; a, the penis and base of epiphallus opened; a′, obliquely transverse section of the penis near the entrance of the epiphallus, showing, above, the end of epiphallus and its terminal pore, and below, the cavity at apex of penis, showing the partition and the orifice leading to the cavity of the penis. B, *Humboldtiana chrysogona*, genitalia of type; b, the penis opened.

Humboldtiana nuevoleonis Pilsbry Pl. 14, figs. 2 a, b.

Humboldtiana humboldtiana nuevoleonis Pilsbry, 1927, Proc. Acad. Nat. Sci. Phila., 79: 176, pl. 12, figs. 1-3, pl. 13, fig. 2.

Helix buffoniana Pfeiffer, Gould 1851, in Binney, Terr. Moll. U. S., etc., 2: 115, pl. 43.

This species was taken originally at El Diente, a place where silver and lead are mined south of and somewhat higher than Monterrey. Specimens from there (no. 164044 ANSP.) were dissected, and the genitalia drawn in fig. 3 B. Shell 33 mm. in diameter.

The penis is very wide and when opened (fig. 3 b) it appears that the epiphallus passes into a broad apical chamber of the penis, which opens into the cavity of the penis by a short verge having a wide cavity and wide, weakly four-parted anterior opening. Below the partition limiting the upper chamber, the penial cavity is nearly filled by a ring of fleshy bodies which give the penis its hard, swollen form. Below them the wall is thinner and softer, with about five wide ridges. The epiphallus is about double the length of the penis, its cavity five ribbed and enlarged anteriorly as mentioned above. The flagellum is very long, more than twice the length of penis and epiphallus together. The penial retractor is attached near (2 mm. from) the base of epiphallus. The vagina tapers anteriorly to rather small diameter. It bears two large dart sacs and two very low vestigial sacs (fig. 3 b′). There is a rather long space between the dart sacs and the

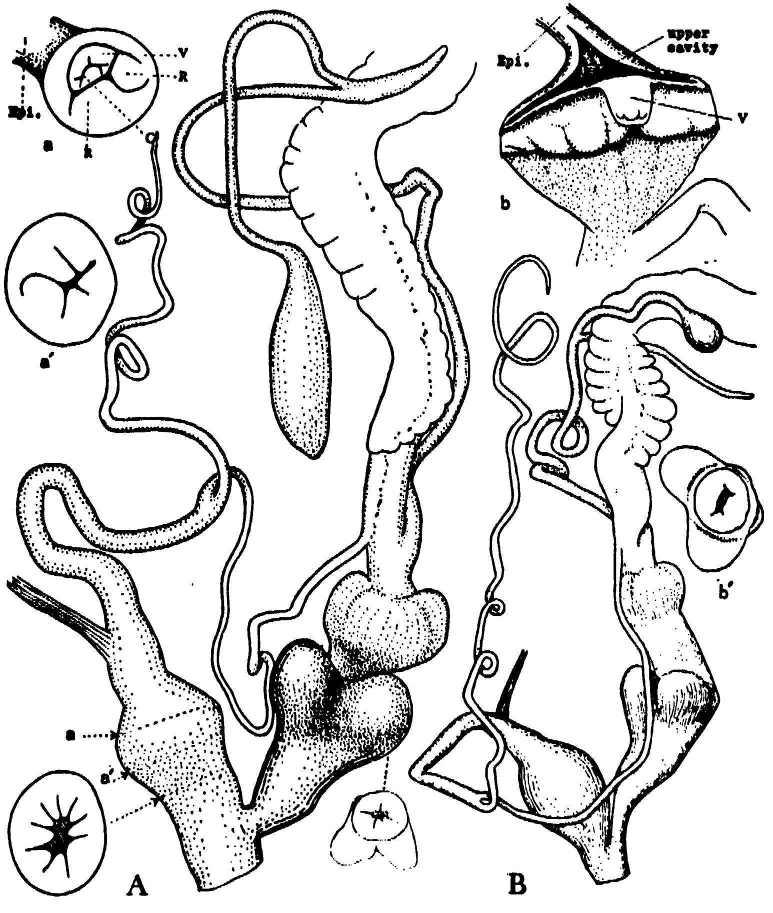


Fig. 3.—Genitalia of A, *Humboldtiana nuevoleonis* from Sierra Guadalupe; a, section of penis and verge; a′, section farther forward, as indicated. B, topotypic specimen from El Diente; b, the penis and base of epiphallus opened; b′, outlines of dart sacs and section of vagina, cut above the dart sacs. Epi., epiphallus; V, verge.

mucous gland ring. The latter consists of four subequal lobes as in other species. The spermatheca is ovate, on a moderately long duct which branches into a long diverticulum. Measurements of length follow:

Penis	8 mm.	Vagina + atrium	19 mm.
Verge	3.5 mm.	Spermatheca and duct	35 mm.
Epiphallus	14 mm.	Diverticulum of same	12 mm.
Flagellum	50 mm.		

The development of only two dart sacs, as in *H. fortis*, the other two being vestigial, is a conspicuous feature. *H. nuevoleonis* is a widely spread species, as now understood, varying materially in size and somewhat in form, both individually and in different parts of its range, but as yet it has been examined anatomically from only two localities.

Specimens similar to the type lot have been seen from the mountains around Monterrey up to about 1700 meters; Alamar Canyon, about two to three kilom. from Alamar on the trail to Pablillo, in the Municipio de Galeana, at about 6000 feet elevation (estimated).

In the state of Coahuila we took rather small specimens, up to about 35 mm. diameter, in San Lorenzo Canyon, southeast of Saltillo, at about 7200 feet, and on the first mountain west of the highway, north end of Carneros Pass at 8300 feet. All of the adults found at these places were dead shells. In shape they are somewhat elevated for this species; sculpture typical.

Those from the Sierra Guadalupe (south of La Cuchilla station near Guadalupe, on the railroad from Saltillo to Parras and Torreon), are typical in sculpture, but the shell is more elevated, the aperture is less oblique to the axis and the outer and basal margins of the lip are very narrowly reflected. The living animal is very light yellowish gray, the face and tentacles gray; edges of the sole orange; sole pinkish buff.

The large shell figured (Pl. 14, fig. 2 a) measures: height 41 mm., diameter 42.6 mm., aperture 30.4 × 29 mm.; 4¾ whorls. This specimen was dissected and the anterior ducts of the genitalia drawn in fig. 3 A. The chief differences from topotypic *nuevoleonis* are in various details of internal structure of the penis, shown in the figures. The epiphallus is longer, three times the length of the penis, and the flagellum is much shorter. The spermatheca and duct are longer, but the diverticulum of that duct is relatively much shorter. As in typical *nuevoleonis* there are only two developed dart sacs, with a low vestige of another. Measurements of length follow:

Penis	9 mm.	Vagina and atrium	20 mm.
Epiphallus	27 mm.	Spermatheca and duct	87 mm.
Flagellum	42 mm.	Diverticulum of same	7 mm.

The Sierra Guadalupe is a local name for the eastern part of the Sierra de Patros which extends about 25 or 30 kilom. east and west, about twelve to fifteen kilom. south of the railroad. The Hacienda Guadalupe, where we were entertained, is near the west end of the Sierra Guadalupe, or at least of its higher part of about 9000 feet elevation. *Humboldtiana* was taken at 7500 to 8650 feet. Extensive foothills of the sierra are brown sandstone.

In the state of San Luis Potosi we took several specimens apparently referable to this species on the hills of Catorce, once a bonanza mining center, but its stately palaces now tenanted only by bats. All timber which may have been on the hills had long ago been cut, and when we were there, before the summer rains, snails were extremely scarce. We found several living young humboldtianas and one adult but fresh " bone," photographed in Pl. 14, fig. 2 b. These shells are very light or nearly white, with faint traces of two bands. The interior is dilute cinnamon-buff and shows no bands. The distinct, closely granulose sculpture is that of *H. nuevoleonis*. These shells were taken on the slope above and west of the town of Santana, at about 9700 feet.

Humboldtiana fortis Pilsbry Plate 12, figs. 9, 10, 11.

Humboldtiana fortis Pilsbry, 1940, Nautilus, 53: 140.—Koestner & Schneider, 1940, Nautilus, 54: 47 (distribution, ecology).

The shell is rather solid and strong, with a very narrow umbilical crevice, globose with short, conic spire; vinaceous-pink, that ground color partly or almost entirely replaced by opaque white in oblique streaks; sometimes showing two pecan-brown bands on the penult whorl. Summit obtuse, the first two whorls smooth, whitish, the last whorl having coarse, unequal low wrinkles along lines of growth and no granulation whatever. The last whorl descends rather deeply in front. The oblique aperture is longer than wide, the interior vinaceous-cinnamon to pecan-brown, fading at the lip which is white, slightly thickened within, outwardly unexpanded, but broadly reflected over and almost closing, the umbilicus. Parietal callus is white or transparent.

Height 39 mm., diameter 37.5 mm., aperture 28 × 25 mm.; 4¾ whorls. Type, Pl. 12, fig. 11.

Height 33 mm., diameter 37 mm. Pl. 12, fig. 10.

Height 30 mm., diameter 29 mm.

NUEVO LEON: Cerro Potosí, northwest of Galeana, Municipio de Galeana, at about 10,000 feet to over 12,000 feet, mainly in the scrub piñon pine zone, but down to the upper limit of pine forest, and up to the alpine meadow at the summit, in rocky areas (C. H. Muller, E. J. Koestner and R. A. Schneider). Type and figured paratypes 164045 ANSP.

Genitalia, figs. 2 A (type), figs. 4 A, B. The large, oblong penis is usually symmetrical but sometimes distended on one side, as in fig. 2 A. The epiphallus has a five-ribbed cavity, opening by a small or rather large pore into a cavity at apex of penis, which is separated from the penial cavity proper by a transverse partition. The internal epiphallic ridges are shortly continued star-like around the orifice on the wall of the apex of penis,

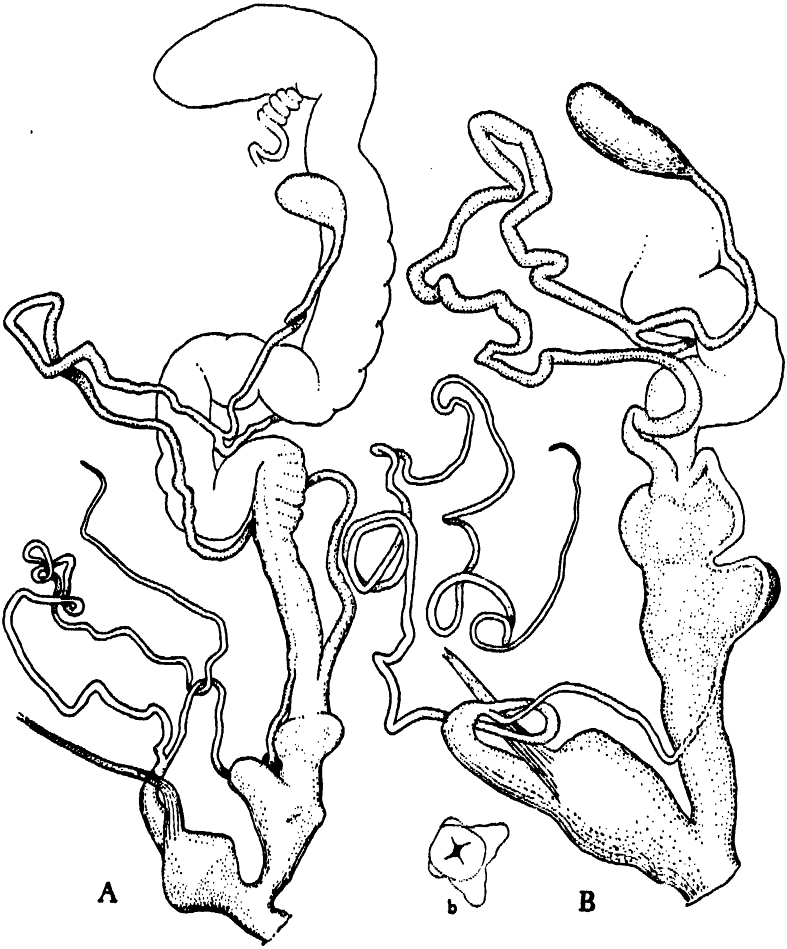


Fig. 4.—Genitalia of *Humboldtiana fortis*. A, specimen from El Cercado. B, Cerro Potosí; b, outlines of dart sacs and section of vagina, from above.

though in the type there is less extensive radial roughness than shown in Pl. 14, fig. 1. In the partition there is an orifice with four- or five-lobed border as in fig. 2 a, the lobes shortly bend towards the cavity of the penis, which is nearly filled by fleshy processes broadly adnate to the walls of the penis. Farther forward these walls have a number of ridges running to the atrium. The epiphallus is as long as, or longer than, the penis. Flagellum is extremely long. The vagina is of moderate length (or sometimes is very long) but varies individually. There are two large dart sacs and two small projections representing vestigial sacs. The spermathecal duct is very long and bears a short branch. Measurements from four specimens follow:

	Type, fig. 2 A	Fig. 4 B		
Penis	8 mm.	12 mm.	11.5 mm.	10 mm.
Epiphallus	14 mm.	11 mm.	11.5 mm.	13.5 mm.
Flagellum	120 mm.	122 mm.	134 mm.	...
Vagina + atrium	20 mm.	...	...	...
Spermatheca and duct	...	109 mm.	...	...
Diverticulum of same	...	20 mm.	...	...

The dull, rudely sculptured surface, absence of granulation and the relatively solid texture characterize the shell of this species. Anatomically the absence of a verge, the large size of the fleshy processes of the penial wall, the very long flagellum, and the presence of only two functional dart sacs are distinctive features.

This snail occurred in abundance, and while *Humboldtiana* in eastern Mexico is usually associated with oak, *H. fortis* lived in coniferous forest.

SONORELLA Pilsbry

Three species of *Sonorella* have been described from northern Mexico by Dr. Paul Bartsch, 1904, Smiths. Misc. Coll., vol. 47, pp. 191, 192, 194. *S. nelsoni* and *S. goldmani* are from the mountains near Lake Santa Maria, Chihuahua, about 30 miles below the New Mexican boundary. These are of the *S. hachitana* type, probably races of that species, which in isolated populations of slightly varying subspecies spreads as far east as Sierra Blanca, Texas. *S. mearnsi* is from the San José mountains, Sonora, about four miles south of the Arizona boundary, a few miles east of the San Pedro River. It has sculpture like *S. granulatissima* and may be related to that species.

None of these has been dissected, so that their affinities to other species are only approximately known.

In western Chihuahua, along the Rio Piedras Verdes and in the mountains south of the river, *Sonorella* was found about 200 miles below the New Mexican boundary, the farthest south now known for the genus. The species here are quite distinct from all of those mentioned above. Probably many more sonorellas remain to be discovered in the northern Sierra Madre, in Chihuahua, and in northeastern Sonora.

Sonorella pennelli new species Plate 13, fig. 5.

The shell is rather solid, depressed, umbilicus contained in diameter about 7 times; pinkish-buff, fading to whitish around the umbilicus and on both sides of a rather wide chestnut-brown band above the periphery and ascending 2 or 3 whorls above the suture. Embryonic 1½ whorls are closely wrinkled or puckered radially, the wrinkles irregular, interrupted; over them are irregular spirals broken into unequal fragments of threads, often crooked, or hyphen-like (- - -); those threads in the peripherad zone are often somewhat better developed. Later whorls have weak wrinkles of growth and a micro-sculpture of more or less granulated lineolation in the direction of growth lines; this is effaced on the last whorl, and it can rarely be seen anywhere on adult shells. The last whorl has an equably rounded periphery and descends rather deeply in front. The aperture is rounded-oval, the peristome somewhat thickened within, the outer and especially the basal margins well expanded, the columellar margin dilated.

Height 12.3 mm., diameter 21 mm., aperture 9.4 mm. high, 11.4 mm. wide; 4⅔ whorls.

The animal is pale yellowish gray with dusky tentacles and eye peduncles. Sole undivided.

Genitalia (fig. 5 B, b). The ovo-testis is voluminous. Hermaphrodite duct is strongly convoluted. The penis is rather long, equal to about half the diameter of the shell, its walls thin in the middle and posterior parts, thicker in the anterior third; there is a loose basal sheath. It contains a short, fleshy, tapering verge (fig. 5 b). The flagellum is well developed. The vagina is about half as long as the penis. Length of penis 12 mm., verge 4.5 mm., epiphallus 9 mm., vagina 6 mm.

CHIHUAHUA: Sierra de La Breña, in steep rock slides above the road from Pearson to Pacheco, at 7000 feet. Type and paratypes 164081 ANSP., collected by Pennell, Harvey and Pilsbry.

This is a rather solid shell with relatively wide band and disintegrated thread-sculpture on the embryonic shell. It is not nearly related to any species of the United States. The diameter varies from 19 to 22 mm. It is sometimes a little more depressed than the figured type, a topotype measuring 10.6 × 20 mm.

The type locality is a long rock slide of lava, partly vesicular, overgrown with lichens, and with some scattered scrub oaks and other bushes. The snails were found next to the earth under a foot or two of rock generally near bushes. " Bones " were rather abundant, but living ones were hard to come by, as the summer rains had not commenced, after a long drought. The place is north of the summit of the range, opposite conspicuous cliffs on the eastern side of the canyon, and can be recognized easily by the elevation of the road at that point and the extensive rock slides. This place was visited in 1934 by Pennell, who found the first specimens, and by Cyril Harvey and the author in 1935. The shells occur from the road at 7000 feet, up the slide to about 8000 feet, near the mountain top.

Sonorella mormonum new species Plate 13, fig. 6.

The shell is moderately depressed, narrowly umbilicate, the umbilicus contained 8 times in the diameter; dilute cinnamon, paler on the base and on both sides of a chestnut-brown band above the periphery. Surface with a somewhat silky luster; the embryonic shell, of 1½ whorls, is closely and

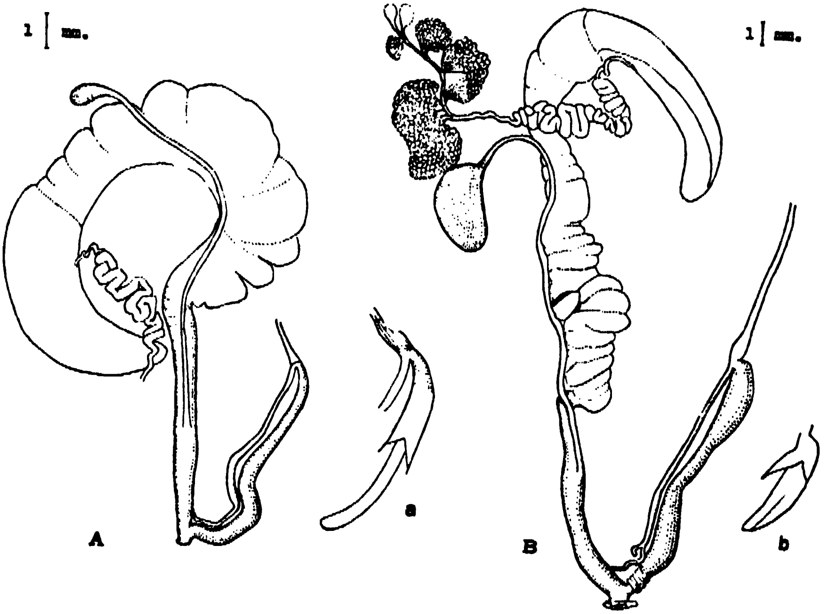


Fig. 5.—A, *Sonorella mormonum,* genitalia, with detail of verge at *a.* B, *Sonorella pennelli,* verge at *b.*

finely sculptured with irregular, interrupted radial wrinkles, after the small smooth initial area; on the peripherad third there are widely spaced forwardly descending threads; on the rest of the surface the threads are irregular, interrupted into uneven, short, often crooked fragments. Subsequent whorls have fine wrinkles of growth and a microscopic, irregular lineolation, or in places granulation, in the same direction; and there are small papillae in slanting trends in some places, elsewhere irregular; these papillae become weak and more widely spaced on the penult whorl, obsolete on the last. The last whorl descends moderately in front. The aperture is rounded, the peristome somewhat thickened within, narrowly expanded in the outer and basal margins, dilated and running forward to the columellar insertion. Parietal callus thin, and like the lip, with a pale buff edge.

Height 8.3 mm., diameter 13.3 mm., aperture 6.9 mm. high, 8 mm. wide; 4⅓ whorls.

Genitalia (fig. 5 A, a). The rather long penis contains a rather slender, cylindric verge, blunt at the end. The penial retractor inserts near the base of the epiphallus. There is no free flagellum, but a short vestige is bound into the general integument at junction of epiphallus and vas deferens. The vagina is about half as long as the penis. Length of penis 7 mm., verge 3.5 mm., vagina 3.5 mm.

CHIHUAHUA: canyon of the Rio Piedras Verdes 3½ miles above Colonia Juarez, in talus of cliffs on south side of the river at 5200 feet. Type and *paratypes 166160 ANSP. Also on the northwest flank of Cerro Moctezuma* at 5800 feet. Collected by Pilsbry and Harvey, June 27 and 28, 1935.

This is a compact and pretty little snail having some resemblance to species of the group of *S. binneyi,* but in the minute sculpture it has some characters of the groups of *S. granulatissima* and *S. dragoonensis;* however, it is not closely related to any species of Arizona.

The southern side of the Piedras Verdes River, at this place, is shut in by cliffs of 100 to 200 feet, with, at the foot, a talus slope of coarse and fine rock and soil, shaded by large maples, a narrow-leaved scrub oak, grape vines, *Rhus* and herbaceous plants. This *Sonorella* was found aestivating attached to small stones.

The specimens from Cerro Moctezuma occurred with *Humboldtiana* among rocks, small scrub oaks, opuntias and grass, on a shelf below a cliff facing west. This place is about half way between Casas Grandes and Colonia Juarez.

Named for the Mormons, who colonized these high valleys of Chihuahua from Utah about 1890.

OREOHELIX Pilsbry

The Mexican species now known belong to the subgenus *Radiocentrum.*

Oreohelix (Radiocentrum) caenosa new species Plate 13, figs. 7, 7a.

The shell is thin, depressed, biconvex, the periphery angular, umbilicus contained 4⅔ times in the diameter; isabella color. Embryonic whorls 1½, the first half turn smooth, the rest narrow, with widely spaced radial riblets. Later whorls have thread-like retractive striae which bear cuticular appendages forming spiral fringes, one in the middle of the upper surface, a second at the periphery, and three or four on the base. In life the whole surface is coated with a closely adhering coat of black soil. The angle of the last whorl becomes blunt or weak near the outer lip. The whorl descends a little to the aperture. Aperture oblique, rounded, the peristome thin and simple.

Height 6.1 mm., diameter 10 mm.; 4⅓ whorls.

CHIHUAHUA: below a cliff at 6200 ft. on the western slope of a mountain about 4½ miles southeast of Pearson (Mata Ortiz). Type and paratypes 166154 ANSP., collected by Harvey and Pilsbry, July 6, 1935.

This is a smaller species than *O. labrenana* with the riblets of the embryonic shell more widely spaced and the cuticular appendages of the thread-like striae far more copiously developed. After death these appendages disappear together with the coat of dirt. The latter cannot be removed without loss of most of the appendages, as it is probably glued on with the animal's mucus.

Plate 13, figure 5 a represents a shell in the natural condition. Figures 5 are dead shells which have lost the periostracal appendages and the coat of dirt.

Oreohelix (Radiocentrum) labrenana new species Plate 13, fig. 8.

The shell is thin, depressed, biconvex, the periphery angular, umbilicus contained four times in the diameter; matt, sepia colored (but fading to tawny-olive in dead shells). Embryonic shell of 1½ to 1⅔ whorls, the initial half whorl smooth, the rest radially ribbed, the ribs narrow, at first separated by spaces twice the width of the ribs, later becoming closer and somewhat retractive. Subsequent whorls with somewhat irregular sharp retractive wrinkles sometimes rather thread-like, continuing on the base but weaker there. In quite fresh shells they have scale-like cuticular processes at the periphery and in the suture. The whorls are convex, the last strongly angular in front, the angle almost disappearing as it nears the outer lip. The oblique aperture is rounded, the peristome thin.

Height 7.3 mm., diameter 14.6 mm.; 4½ whorls. Type.
Height 7.6 mm., diameter 15.2 mm.; largest specimen.

CHIHUAHUA: Sierra de La Breña in a rock slide above the road from Pearson to Pacheco, at 7000 ft., collected by H. A. Pilsbry and Cyril Harvey, June 30 and July 5, 1935. Type 166587 ANSP.

This snail was found dead in a rock slide with *Sonorella pennelli* and other snails. Though dead shells were not rare, no living ones could be found. Our visit was after many months of drought.

It has much resemblance to *Oreohelix clappi* of the Chiricahua range, Arizona, which it resembles in size and periostracum, but it is apparently more nearly related to *O. ferrissi* of the Big Hatchet range, New Mexico, which has similar, though coarser, embryonic sculpture. In some immature examples the base shows some crimping of the thread-like striae, such as I have figured for *O. clappi emigrans* (Proc. Acad. Nat. Sci. Phila., 1910, p. 79, fig. 7), but much less conspicuously developed. In some other fresh shells the base is plain, the thread-like striae almost wanting.

ASHMUNELLA Pilsbry & Cockerell

Ashmunella meridionalis new species Plate 13, fig. 3.

The depressed shell is thin, cinnamon colored above, the base lighter, tawny-olive. Umbilicus rapidly widening in the last whorl, contained almost 5 times in the diameter. Spire convex, of 5⅓ convex whorls, the last rounded peripherally, descending slightly in front, constricted behind the lip. The surface is nearly lusterless above, the base slightly shining; first 1½ whorls are densely papillose, the papillae radially lengthened; succeeding whorls are very weakly and finely wrinkle-striate, and with papillae in rather irregular, forwardly descending trends; in young shells, and generally on the last whorl of adults, the papillae bear short, stiff hairs (usually in great part lost by wear). The last whorl shows also the dense microscopic spiral lineolation common to the genus. The aperture is rotund-lunate, the very palė rufous peristome forming about three-fourths of a circle, reflected throughout, the outer and basal margins thickened within.

Height 6.5 mm., diameter 13.5 mm.

CHIHUAHUA: "Barranca Colorado," 21 miles south of Miñaca. Type, 164084 ANSP., and paratypes collected by the author. Also taken at San Pedro, 10 kilom. south of Miñaca.

In some of the shells there is the scarcely noticeable vestige of a tooth in the outer-basal position. The densely sculptured embryonic shell and the hairy later whorls are its more peculiar features. It is farther south than any other known *Ashmunella.*

The shells from San Pedro live on a light-colored igneous rock in a ravine dissected in the rocky bank of the river, near the ford. No living ones were found, but fresh "bones" do not show hair-scars on the last whorl or two, and they have a half whorl more than the type lot. One measures, height 6.4 mm., diameter 14.4 mm., 5¾ whorls. The smallest has a diameter of 13.3 mm.

The upper surface of the foot and head are drab-gray.

The retractor muscle system is substantially as figured for *A. tetrodon.*

The lung is 15 mm. long, copiously maculate with black along both sides of the pulmonary vein, the maculae irregular, partially confluent between this vein and the hindgut.

Jaw with about 9 ribs, the lower margin irregular.

Genitalia (fig. 6 F). Penis with the lower sac large, the upper narrow. Lower sac with nearly simple internal walls (fig. 6 I); in the upper sac there are three thick longitudinal ridges (fig. 6 H). Epiphallus with triramose cavity and thick muscular wall (fig. 6 G). Vas deferens is very long and runs along the inner curve of the visceral coil. There is a strong penial retractor on the epiphallus and the usual loose strands connecting penis with base of epiphallus. The vagina is somewhat swollen in the middle. Spermathecal duct very long. Talon of the multilobular type (fig. 6 E). Length of penis 4 mm., epiphallus 31 mm., vagina 3.5 mm., spermatheca and duct 22 mm.

It is not easy to estimate the affinities of toothless ashmunellas closely. By the structure of the penis, this form belongs nearer to species of the Chiricahua Mountains than to other Mexican species now known.

Ashmunella juarezensis new species Plate 13, fig. 2.

The shell is strongly depressed, thin, light brown; umbilicate, the umbilicus contained 4½ times in the diameter. Spire feebly convex, of weakly convex whorls, the last angular at the periphery, very slightly descending in front, constricted behind the peristome. The surface is slightly shining; first half whorl nearly smooth, the following half or two-thirds of a turn closely and sharply sculptured with curved, retractive striae (and in perfectly preserved young shells showing some curved, forwardly ascending

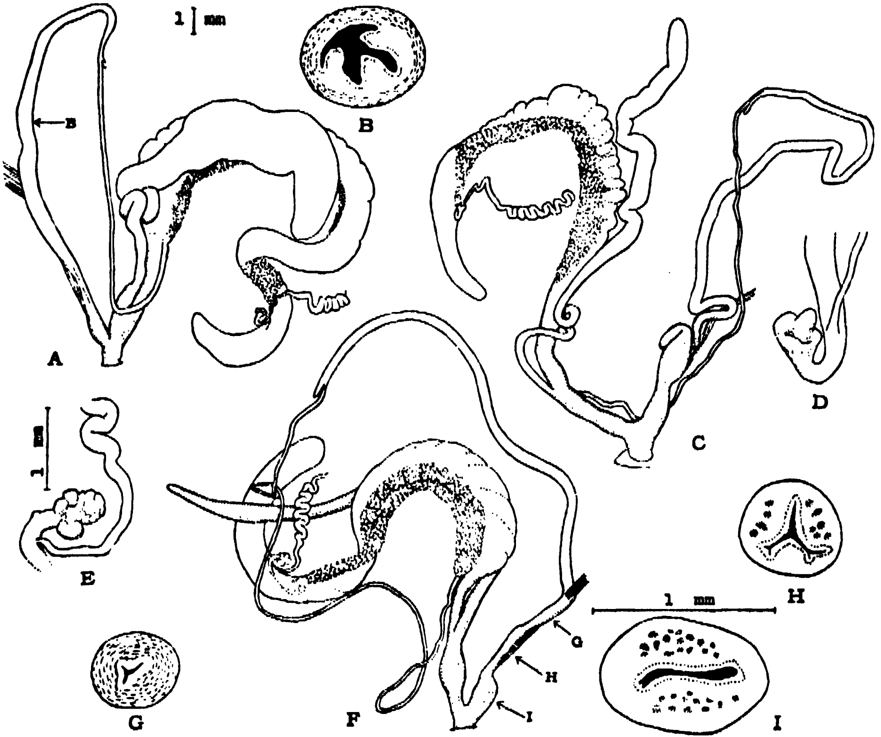


Fig. 6.—A, *Ashmunella montivaga*. B, section of epiphallus. C, *Ashmunella juarezensis;* D, talon. E, *Ashmunella meridionalis,* talon; F, genitalia; G, section of epiphallus; H, I, sections of upper and lower sacs of penis. Figures A, C, F drawn to one scale; figure D and all sections drawn to one scale.

trends of papillae spaced like the striae). The post-embryonic whorls have weak, fine striation, and the inner ones are more or less papillose, the papillae radially lengthened, disappearing on the last two whorls. The dense microscopic spiral lines common to the genus, together with an equally fine oblique lineolation, produce a microscopic granulation. The aperture is strongly oblique, lunate. Peristome white, reflected, recurved at base, thickened within and on the face.

Height 6 mm., diameter 13.2 mm.; 5 whorls. Type.
Diameter 12.3 mm. to 13.7 mm. Topotypes.

CHIHUAHUA: southern side of the Rio Piedras Verdes 3½ miles above Colonia Juarez, aestivating in the earth under rocks, on the talus of cliffs, elevation 5200 ft. Type and paratypes 166161 ANSP., collected by Cyril H. Harvey and the author, June 27, 1935. Also found on the northern side of the river about 5½ miles above Colonia Juarez; 3 miles northwest of Pacheco in a ravine on the road to the sawmill; and in talus of cliffs on the Rio Piedras Verdes, 2 miles below Pacheco, at 5900 ft.

This snail of the Rio Piedras Verdes valley is related to *A. meridionalis* by its toothless aperture, but it differs by the absence of hairs, the less broken sculpture of the embryonic shell and the distinctly angular periphery. It occurs abundantly in the type locality, our station 174, associated with *Sonorella mormonum, Humboldtiana högeana* and other snails.

In the station mentioned, on the north side of the river, it lives among stones under a cliff, about 25 feet above the river. Here the shells are mostly smaller than in the type lot, from diameter 11 mm. with 4½ whorls, to diameter 13 mm. with 5 whorls.

Genitalia (fig. 6 C). The penis is contracted in the middle, the upper sac at least as large as the lower; epiphallus is very long. The flagellum has a short free end and a rather long (2 mm.) part bound in with the vas deferens. Vagina is slightly shorter than the penis. The spermatheca is fully equal to the epiphallus in length. Talon (fig. 6 D) with about four unequal lobes. Length of penis 5 mm., epiphallus 21 mm., vagina 4.5 mm., spermatheca, 23 mm.

Though this snail resembles *A. meridionalis* by its toothless aperture, it is not nearly related to that species, which belongs to the series having the upper sac of the penis narrow, as in Chiricahuan ashmunellas. In *A. juarezensis* the upper sac is as large as the lower, as in species of the Huachuca range.

Ashmunella montivaga new species Plate 13, fig. 1.

The shell is similar to *A. juarezensis* except that the periphery is a little less sharply angular, and the *last whorl descends* decidedly in front; the whorl are *more closely coiled;* the striae of the embryonic shell are more interrupted, and the papillation of the post-embryonic whorls is more distinct. Umbilicus contained nearly 6 times in the diameter.

Height 6.5 mm., diameter 14.1 mm.; 5½ whorls.

CHIHUAHUA: Sierra de La Breña, in a rock slide above the road from Colonia Juarez and Pearson to Pacheco, at 7000 ft. elevation. Type 166158 ANSP., collected by Pilsbry and Harvey, July 5, 1935.

In a long series the extremes measure 13.1 and 15.2 mm. diameter; whorls 5½ and 5¾. There is often an extremely shallow notch in the internal callus in the basal margin, a little left of the middle, probably a souvenir of lost teeth. In some other shells no trace of this can be seen.

It was found in the slide which produced *Sonorella pennelli* and other snails.

Genitalia (fig. 6 A). The penis is extremely short, not divided into distinct upper and lower sacs. The epiphallus is narrow at first, then dilating to a diameter greater than the penis, its cavity lobed (fig. 6 B, section). The muscular layer is not so thick as usual. The base of the epiphallus is united with the penis by delicate fibers. The flagellum is minute. The vagina is very short. Spermatheca is extremely voluminous, similar in two individuals opened. Talon four-lobed. Length of penis 2 mm., epiphallus 15 mm., vagina 2 mm.

In addition to the shell characters mentioned above, this snail differs from *A. juarezensis* in numerous details of the genitalia. The penis and vagina are far smaller. The epiphallus is shorter but of larger diameter. The spermatheca is very bulky. As the specimens were taken at nearly the same time, both species aestivating after a long dry season, and they were prepared in the same manner, the differences from *A. juarezensis* seem significant. They were confirmed by examination of three specimens of *juarezensis* and two of *montivaga*.

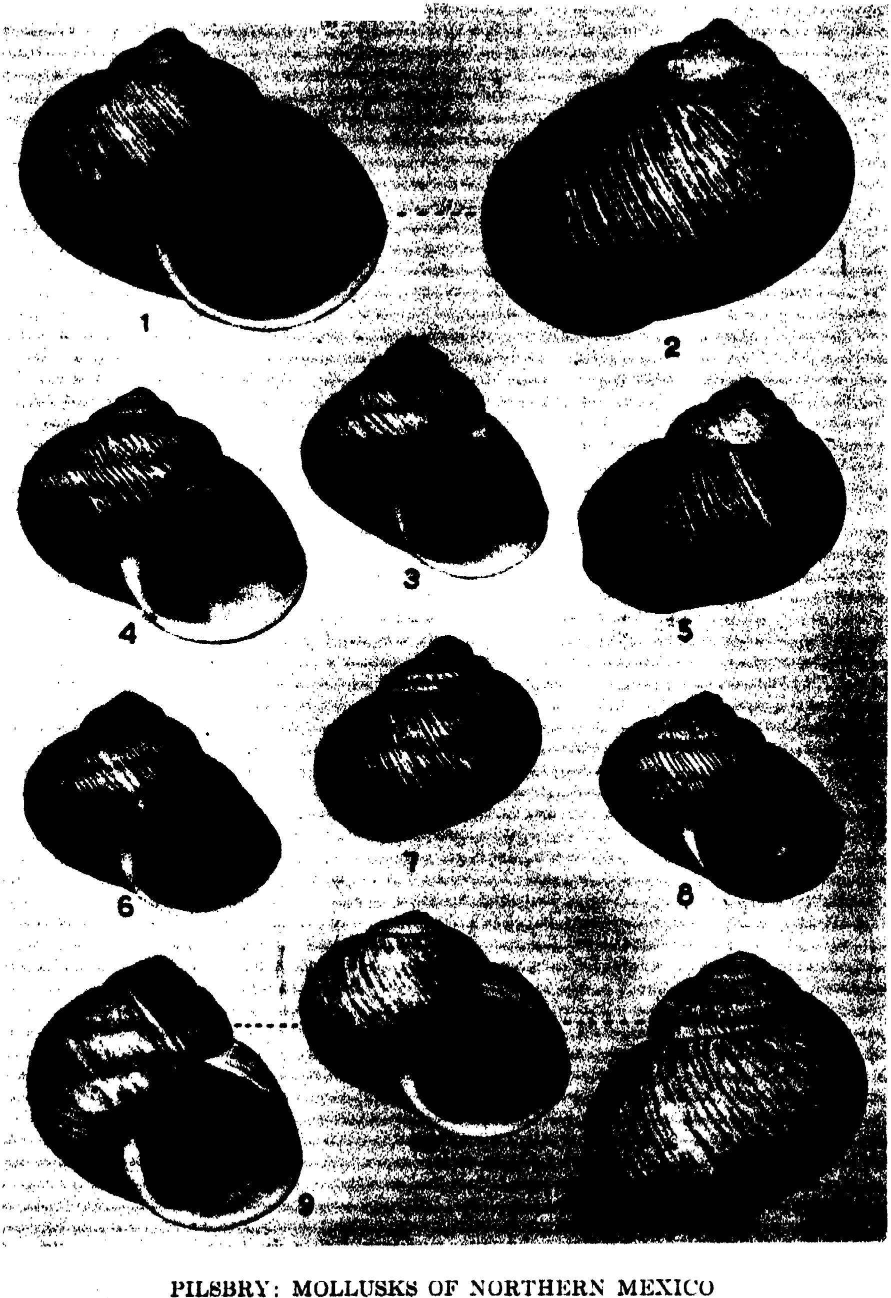
Ashmunella intricata new species Plate 13, fig. 4.

The shell is depressed, small; dilute cinnamon-buff, with a buff spot behind the upper angle of the aperture; umbilicate, the umbilicus contained 5 to 6 times in the diameter. The slightly convex whorls increase very slowly in width, the last being *acutely angular* at periphery, descending a little in front, deeply constricted behind the outer and basal margins of the peristome. The surface is nearly matt; first half whorl smooth and glossy, next whorl very closely, finely and sharply striate, some striae interrupted. Subsequent whorls have light wrinkles of growth and papillae in irregularly oblique trends; on the last whorl the papillae are obsolete, represented by weak scars, wanting on the base; preceding the contraction behind the lip there are a few stronger wrinkles. The whole surface, after the initial smooth half-whorl, shows the microscopic spirals characteristic of the genus. The strongly oblique aperture is somewhat triangular, the peristome white, reflected, thickened within and on the face, the insertions remote, connected by a straight, *strongly elevated callus.* Within the outer lip is a flat-topped tooth; within the basal lip two compressed, shortly entering teeth; the interdental intervals equal. On the parietal wall there is an oblique tooth, its forward end turning abruptly towards the columella; from near its inner end a thinner, lower tooth runs to the posterior insertion of the outer lip.

Height 4.7 mm., diameter 9.6 mm.; 5¼ whorls.
Height 4.8 mm., diameter 10.6 mm.; 5⅓ whorls.

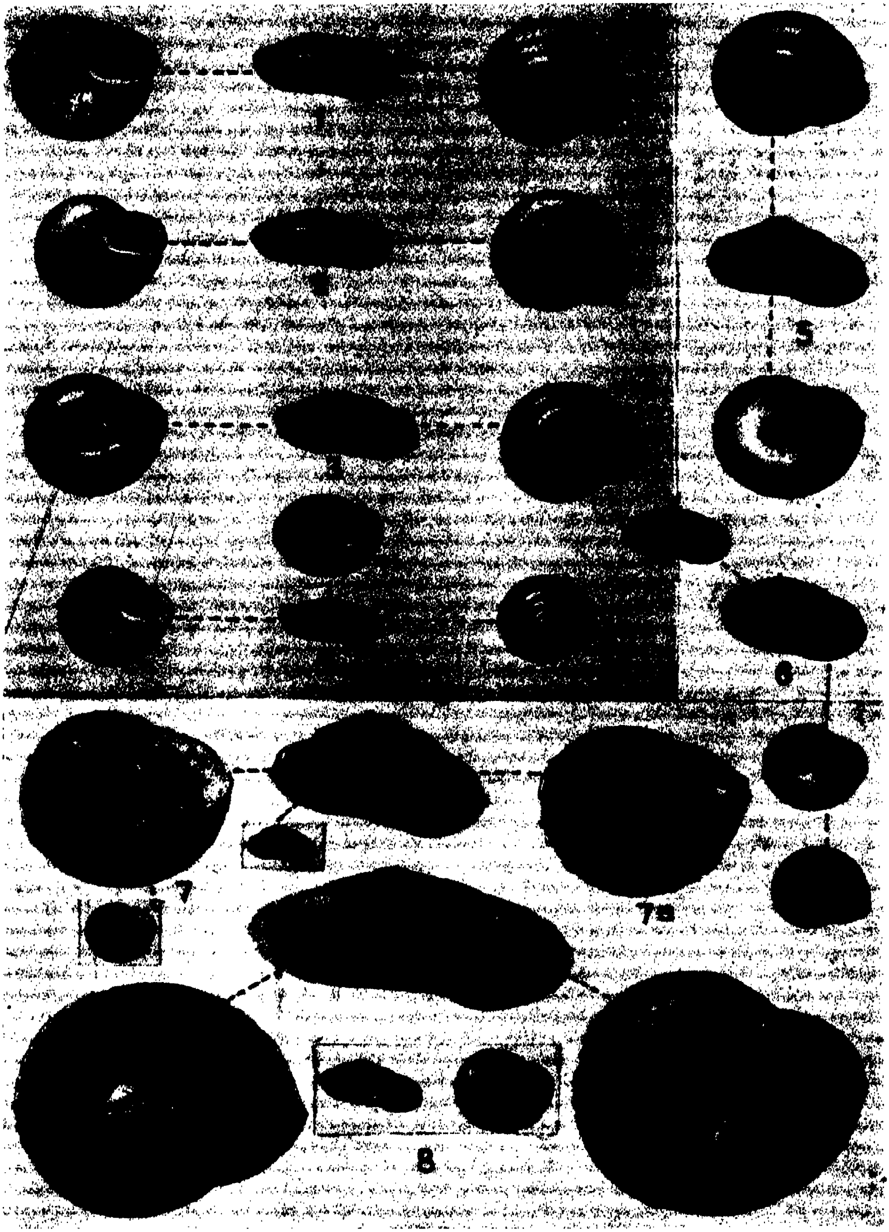
CHIHUAHUA: mountain side about 4½ miles southeast of Pearson (also known as Mata Ortiz), among stones at the base of a cliff at 6200 ft. Type and paratype 166324 ANSP., collected by Cyril Harvey and the author, July 6, 1935.

This is a species of the group of *Ashmunella mearnsi.* By the conformation of the aperture it resembles the New Mexican *A. hebardi,* but the Chihuahuan species is far smaller, with smaller umbilicus and more closely coiled whorls. It is also somewhat less sharply carinate.



PILSBRY: MOLLUSKS OF NORTHERN MEXICO

Figs. 1-2.—*Humboldtiana montezuma*. Figs. 3-8.—*H. m. inferior*. Figs. 9-11.—*H. fortis*.



PILSBRY: MOLLUSKS OF NORTHERN MEXICO

Fig. 1.—*Ashmunella montivaga*. Fig. 2.—*A. juarezensis*. Fig. 3.—*A. meridionalis*. Fig. 4.—*A. intricata*. Fig. 5.—*Sonorella pennelli*. Fig. 6.—*S. mormonum*. Fig. 7, 7a.—*Oreohelix cacnosa*. Fig. 8.—*O. labrenana*.

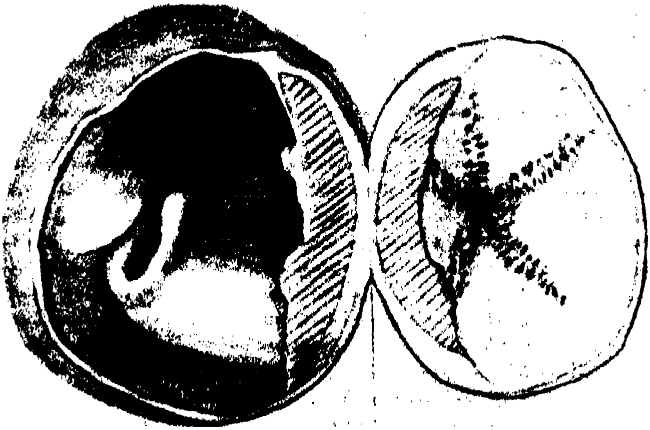


Figure 1

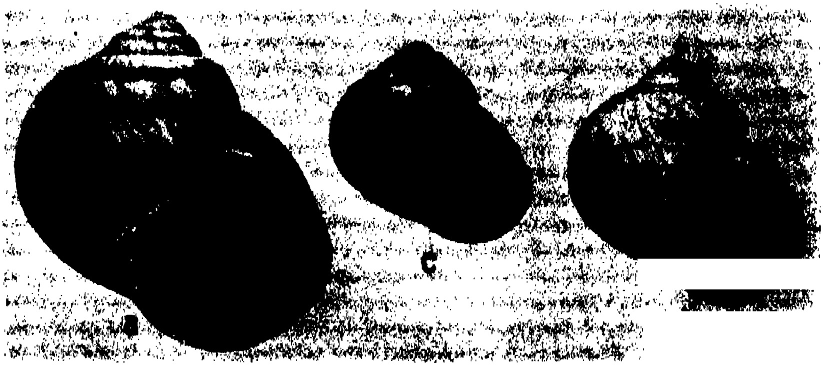


Figure 2

PILSBRY: MOLLUSKS OF NORTHERN MEXICO

Fig. 1.—Section near apex of penis in *Humboldtiana fortis*, the septum between apical vergic cavity and cavity of penis removed. At the right is seen the upper wall with pore communicating with the epiphallus, surrounded by star-shaped corrugations. At left is the cavity of penis nearly filled by fleshy bodies.

Fig. 2.—a, *Humboldtiana nuevoleonis*, Guadalupe Mountains, Coahuila. b, Catorce, San Luis Potosi. c, *H. chrysogona*, type, Concepción del Oro, Zacatecas.

A REVISION OF THE GENUS PEDICULARIS IN CHINA. PART I[1]

BY HUI-LIN LI

Research Associate, The Academy of Natural Sciences of Philadelphia,
and Harrison Fellow for Research in Botany,
University of Pennsylvania

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INTRODUCTION

ACKNOWLEDGMENTS

This work was prosecuted during the tenure of a Harrison Fellowship for Research of the University of Pennsylvania from 1943-46. To the authorities of the University, the writer is indebted for their kindness and generosity. He wishes also to acknowledge his sincere gratitude to Dr. J. R. Schramm, Head of the Department of Botany of the University of Pennsylvania and to Dr. E. D. Merrill, Director of the Arnold Arboretum of Harvard University for their constant encouragement and kindly advice, and to Dr. F. W. Pennell, Curator of Plants of the Academy of Natural Sciences of Philadelphia and authority on the family Scrophulariaceae, whose untiring help and expert guidance made possible the completion of this work. Its actual prosecution was at the Academy of Natural Sciences of Philadelphia, to whose President, Mr. Charles M. B. Cadwalader, the writer wishes to express his thanks for placing its splendid herbarium and library facilities at his disposal. He also owes thanks to many staff members of the Academy who had directly or indirectly aided the work and the associations with whom remain a happy memory. Lastly to the curators of the different herbaria mentioned below, who have kindly loaned specimens for this study, the writer wishes to tender his thanks for their kindness and cooperation.

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[1] Part II of this paper will appear in the next volume of these Proceedings.

HISTORICAL FOREWORD[2]

The foreword to a taxonomic study should tell the scope of the project undertaken, the sources of information for it, the history of what has been already accomplished in its field, and why a new review has been made. This may be simply to bring our knowledge up to date, or it may be, as in the present case, because new insight can yield a view richer than any of its predecessors.

Dr. Hui-Lin Li presents us with a comprehensive account of the species of the genus *Pedicularis* in China. This is one of the largest genera of flowering plants in the North Temperate Zone, and about half of its known species are Chinese. He now numbers these as 282, but this figure is certain to increase with future botanical exploration until the Chinese species become about two-thirds of some 800 or 1000 species. I agree with Dr. Li that the flowers of *Pedicularis* show a diversity likely unequalled by any other genus of flowering plants, and yet that the genus is a thoroughly natural one, its vastly divergent trends being all inextricably bound into a united whole. Merely to show these trends and to indicate clearly the unit species, both structurally and in relation to their geographical backgrounds, becomes a great task.

The sources of information for the present monograph lie in the collections of the many botanists whose specimens are cited in the lists under each species. These collectors are considered individually by Dr. Li in the summary that follows this Foreword.

The history of what has been accomplished in the study of these collections, so far as regards the proposing of taxonomic entities, can be given thus. We may show the growth of our acquaintance with the Chinese forms of *Pedicularis* by following the sequence of the describers of the species, telling for these upon whose collections and from what provinces they were based. The steadily broadening conceptions as to the classification of these species is specially discussed by Dr. Li.

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[2] By Francis W. Pennell, Academy of Natural Sciences of Philadelphia.

The history of our knowledge of *Pedicularis* in China falls into two main periods: (a) before the work of Maximowicz; and (b) the work of Maximowicz and after. With Maximowicz' first paper of 1878 commenced the describing of species from China itself, and it is in the interior mountains from Kansu to Yunnan that endemic species of this genus abound. Also, he first gave a satisfactory classification of the genus, presenting this for the World in his great treatise of 1888.

(*a*) *Before Maximowicz.*—Except for a few described after 1840 from remote western portions of the Chinese Empire, western Sinkiang and Tibet, all the species of this period now known to occur in China were first described from other territory. Earliest of these are six plants known to Linnaeus in the first edition of his Species Plantarum (1753), being *P. comosa, P. palustris, P. sceptrum-carolinum,* and *P. verticillata* from Europe and across northern Asia, and *P. resupinata* and *P. tristis,* wholly from eastern Asia. Next, as a result of a journey to eastern Siberia, Pallas (*72*) in 1776 added three further species, *P. flava, P. spicata,* and *P. striata,* that have subsequently proved to be Chinese. Similarly, *P. labradorica* Wirsing, dating from 1778, although described from northeastern North America, occurs across Arctic America to eastern Siberia and even into northern China. In 1800 Willdenow (*89*) added 5 more Siberian species that enter our study, four of which had already been indicated and named by Stephan. In 1806 Hornemann published *P. oederi* Vahl from Norway, an Arctic plant that reaches the mountains of China and those of the western United States. From eastern Siberia were added in 1811 *P. longiflora* Rudolph, gathered by its describer at Lake Baical; and in 1812 *P. grandiflora* Fischer, of uncertain origin. From interior southern Siberia were published in 1823 *P. abrotanifolia* Bieberstein and *P. altaica* Stephan, each collected and named by the botanical traveller indicated, although appearing in the monograph of *Pedicularis* by Steven (*86*). This was a remarkable study for its time, the earliest known to me with dichotomous keys to distinguish the component species. Of its 49 species none was assigned to China, although some 15 actually occur there.

Pedicularis carnosa Wallich of 1828, antedated by *Rhinanthus bifidus* Buchanan-Hamilton ex Don (*36*) of 1825, both described from Nepal, occurs in southwestern China.

In the papers of Bunge from 1830 to 1849 we have 5 more species that occur in far western China, although described by him from Russian territory; three of these were based on his own collections, but *Pedicularis fissa* Turczaninow and *P. venusta* Schangin were both gathered and named by those botanists. Another Russian botanist, Schrenk, first crossed into Chinese territory, and his *P. rhinanthoides,* published in 1841, was the first species of this genus described from Chinese soil; it was followed in 1842 (*83*) by 5 others, all, like it, from Dzungaria ("Songaria"). Schrenk was immediately followed by Karelin and Kirilow, who travelled together to the Alatau Range in Dzungaria in 1841, and 1842 published therefrom 2 new varieties of *Pedicularis*.

Two travellers of this period who visited the Himalayas published species that extend into Tibet: they are Jacquemont, with *Pedicularis labellata* in 1844; and Klotzsch, with *P. tubiformis* that was actually gathered by the ill-fated Hoffmeister on Prinz Waldemar's expedition in 1846, although not published until 1862.

In 1868 Regel (*81*) published *Pedicularis semenowi*, which had been collected by Semenow in 1857 on the Alatau Mountains in Sinkiang; in 1869 Ruprecht published 2 species collected by Osten-Sacken on the Tian-Shan Mountains in Sinkiang; and, finally, in 1879 Regel added 2 further species from Sinkiang, one gathered by himself, the other by Fetisow.

For the first century and a quarter from the time of Linnaeus, no species had been described from China itself. Of the describers over this long period, Linnaeus worked and published in Sweden, Willdenow and Klotzsch in Germany, Hornemann and Wirsing in Denmark, Jacquemont in France, Don and Wallich in India or England, but the majority of describers of Chinese species of *Pedicularis*, Pallas, Rudolph, Fischer, Steven, Bunge, Schrenk, Karelin, Kirilow, Regel, and Ruprecht, were in Russia. This Russian predominance of interest in these plants (and in the flora of this part of Asia) continued into the next period, Maximowicz himself being Russian and working and publishing in Russia.

(*b*) *Maximowicz to the present.*—Of those who have hitherto contributed to our knowledge of *Pedicularis*, whether in China or throughout the World, the greatest is Maximowicz. This is both as a describer of species (*64-66*) and as the organizer of our knowledge of the genus (*66*). In his three papers of 1878, 1881, and 1888 he proposed as new, 65 species, among which (as already stated) are the first described from China itself. From the collections made by Russian botanical travellers he described 18 species gathered by Przewalski in Kansu (13), Mongolia (3), Ningshia (1), and Tibet (1); 13 species by Potanin in Szechuan (8), Kansu (4), and Mongolia (1); and 1 each by Artselaer in Mongolia, Tatarinow in Jehol, and Schmidt in Manchuria. From the English collector, Augustine Henry, he described 1 species from Hupeh; and from French missionary collectors, 2 species gathered by David in Szechuan, and 30 species by Delavay in Yunnan. Maximowicz' organization of the genus, published in 1888, is distinguished by comparable drawings of the flowers of most of the species; the significance of its views as to classification is discussed below by Dr. Li.

Although he collected in Sikkim so early as 1849, it was not until 1884 that J. D. Hooker (*52*) published his new species of *Pedicularis;* of these 4 extend into the mountains of southwestern China.

As the second great describer of Chinese species of *Pedicularis* must be reckoned Franchet, whose publications (*43-47*) extend from 1883 to 1900. He was in touch with French missionaries in Yunnan and Szechuan, and also saw the plants obtained by French travellers. The series of 30 species collected by Delavay in Yunnan, just mentioned as published by Maximowicz, had been previously studied by Franchet and nearly all bear names proposed by him. So do 10 more gathered there by Delavay, of which 7 were included in Forbes & Hemsley's Enumeration (*41*) and only 3 published directly by Franchet. Mostly in association with Bureau, Franchet published in 1891 (*30*) 8 species gotten by Prince Henri d'Orleans and Bonvalet in Sikang (7) and Szechuan (1); and for himself 1 gathered by that expedition in Yunnan. Further, on his own account, Franchet published 20 other species, based on collections made by Soulié in Sikang (6) and Szechuan (2), Farges in Szechuan (4), Mussot in Sikang (3) and Szechuan (1), David in Szechuan (3), and Provôt in Chahar (1). Although Franchet's species total 68, their presentation lacks the organization of the work of Maximowicz.

In 1890 were published the Scrophulariaceae in Forbes & Hemsley's "Enumeration of all the Plants known from China proper", etc. (*41*). It contained 94 species of *Pedicularis* from the Chinese Empire, which then included the adjacent islands that have only recently returned to it, as well as Korea; among these species, in addition to those suggested by Franchet, Hemsley described 2 based on Henry collections from Yunnan and 1 on a plant gathered by Faber in Szechuan.

Prain, the author of a magnificent account of the Indian species of *Pedicularis*, with a synopsis of those of the whole World (*75*), published elsewhere in 1893 (*79*) 2 species based upon plants collected by Pratt in Sikang.

Before the close of the nineteenth century must be added 2 further species gathered and described by Russians: in 1889 *Pedicularis maximowiczii* Krassnow, collected by him in the Tian Shan Mountains of Sinkiang; and *P. borodowskii* Palibin, collected by Borodowsky in Mongolia.

Over the first quarter of the twentieth century Gustave Bonati, a French pharmacist, undertook a special study of *Pedicularis*. He assembled an herbarium largely devoted to this genus, although he also described many species from the collections at the Museum d'Histoire Naturelle at Paris. No one has published so many Chinese species of this genus as he, 77 appearing in many papers (*4-24*) from 1900 to 1927. Like Franchet he obtained ample collections from the Catholic missionary fathers in Yunnan and

Szechuan, while in later years collections made by various British and American botanical collectors were referred to him for identification. To the former group pertain collections made by Soulié in Sikang (13) and Yunnan (3), Maire in Yunnan (6), 2 each by Delavay, Ducloux, and Monbeig in Yunnan, and 1 each by Farges and Legendre in Szechuan, Bodinier or Cavalerie in Kweichow, and Giraldi in Shensi; to the latter pertain collections by Wilson in Hupeh or Szechuan (5), Forrest in Yunnan (15), and Sikang (1), Kingdon Ward in Yunnan (7) and Sikang (6), and Rock in Yunnan (12) and Szechuan (1). From collections of an earlier day he described 1 species based on a plant gathered by Przewalski in Kansu; and, indicative of the new interest in their own flora developing among the Chinese themselves, another species, also from Kansu, collected by Ching. Bonati's views on the classification of the species of *Pedicularis* are discussed below by Dr. Li, and at the end of this Foreword we shall see what became of his private herbarium.

Dr. Diels of the Berlin Botanical Garden described in 1900 (*31*) and 1905 (*32*) 4 species of *Pedicularis* gathered by Giraldi in Shensi; in 1911 (*33*) 1 gathered by Futterer in Chinghai; and in 1930 (*35*) 3 by Rock in Kansu and Chinghai.

In 1915 Hayata[3] described *Pedicularis transmorrisonensis* from the high mountains of Taiwan (Formosa), an area not included in the present study. His type is presumably in Japan.

In 1922 Paulsen described *Pedicularis svenhedinii*, collected by Sven Hedin in southwestern Tibet.

From 1914 to 1918 Handel-Mazzetti travelled extensively in western China, obtaining many specimens, the new species among which were described in a series of papers (*49*) culminating in his Symbolae Sinicae (*50*). Between 1920 and 1936 he published 20 species of *Pedicularis*, 15 from Yunnan, 3 from Sikang, and 2 from Szechuan.

Limpricht also travelled and collected in China during the period of the First World War, publishing from his own collections (*56, 57*) 5 new species of *Pedicularis* from Sikang. His enumeration of the species of the World, issued in 1924 (*58*) is considered below by Dr. Li.

Vvedensky in 1925 added 1 species that he had gathered in central Asia.

Beside Bonati's report on Kingdon Ward's collections, Marquand and Airy-Shaw in 1929 (*62*) published 3 further species that he had gathered in Sikang.

Finally, Pai in 1934 (*69, 70*) identified and presented a list of various collections of this genus in China, and published 1 species based upon an older variety. He is the first Chinese proposer of a species of *Pedicularis*.

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[3] Icon. Plant. Formos., 5: 126, 1915.

So far as Dr. Li and I are aware there have been no new species of *Pedicularis* described from China for nearly twenty years. This is a natural result of turmoil both within China and over the World.

Our historical sketch shows that our past knowledge of *Pedicularis* in China has been due in greatest measure to three botanists. Maximowicz, the Russian, both organized our classification and described the first species, and these in considerable number, from China proper. Franchet and Bonati, both French, described many more species from China, and the latter planned, but failed to carry out, a reorganization of our classification. Maximowicz' study was especially satisfactory, because of the comparative drawings of the flowers of the various species, a feature not attempted by either of the others. Now, Dr. Li, a Chinese student, takes up the study of this genus, so remarkably developed in China.

The inception of the present monograph calls us back to consider the fate of the large private herbarium assembled by Bonati in France. After his death in 1927, this was offered for sale and was purchased by Dr. E. D. Merrill in 1928 on behalf of the newly organized California Botanic Garden near Los Angeles in California. On its arrival Dr. Merrill sent the Scrophulariaceae on loan to the Academy of Natural Sciences of Philadelphia for my review, granting me permission to retain for that institution a set of its many duplicates. The series proved to contain some 2,500 specimens of *Pedicularis*, this genus constituting fully half of Bonati's Scrophulariaceae. It was only toward 1940 that I found sufficient time to prepare a list, with verified place of publication and quoted statement of the source of material studied, of the 640 species of *Pedicularis* that have been described from the Old World. Then, in 1940 and 1941, I went through both the Academy's and Bonati's specimens of *Pedicularis*, identifying them, but putting aside many collections, especially from China, that evidently represented species new to science. When Dr. Merrill learned of this work, he insisted upon loaning me Harvard's rich collections of this genus from China, although I earnestly assured him that I had not the time to undertake their study soon. But my counter-suggestion of a year or so later, that the study of *Pedicularis* in China would make an admirable project for a Chinese research student, met his full response, with the remark that he had then at the Arnold Arboretum just the person for the task. That was Hui-Lin Li, who had recently obtained his doctor's degree at Harvard University. With the aid of Dr. Schramm of the University of Pennsylvania, through whose advocacy Dr. Li held for two and a half years (1943-1946) a Harrison Fellowship for Research there, the project of this study was fulfilled.

What Dr. Li has accomplished is evident in the following monograph. His revision is limited to the species of *Pedicularis* that occur in China (including Manchuria, Mongolia, Sinkiang, and Tibet). Following the manner of Maximowicz, he both illustrates by his own line-drawings the flowers of each species and also organizes the species into natural groups. Most of those now considered, have been described subsequent to the time of Maximowicz, and so are now illustrated, and often assigned as to relationship as well, for the first time.

Dr. Li recognizes 282 species of *Pedicularis* as now known to occur in China. " A number of these, however, owing to lack of type or authentic material, are retained here only in doubtful status. Some of them may eventually be reduced to synonymy when material is available for study." Fifty-two (52) new species are now being described. Some new combinations and new names are formed, many new varieties are proposed, and a number of specific names are reduced to synonymy. The new species, with record of province and collector, may be summarized as: from Chinghai gathered by Rock (1); from Hupeh by Wilson (1); from Kansu by Rock (2); from Kweichow by Steward (1) and Tsiang (1); from Sikang by Chiao (1), Rock (13), Soulié (1), Stevens (1), and Wang & Wen (2); from Sinkiang by Schrenk (1); and from Yunnan by Ching (1), Feng (2), Forrest (3), Rock (5), Tsai (1), Wang (2), and Yü (12).

I think that the main value of Li's monograph lies in the clearness of his presentation of species and his endeavour to understand the evolution of the genus. He gives us a philosophic comprehension of the evolutionary trends within this great complex of related organisms, and makes us realize that its deployment into a multitude of endemic species is a dynamic movement of its geologic present. Although, as with his great predecessors in the study of the Chinese species of *Pedicularis*, with Maximowicz, Franchet, and Bonati, he has not had the good fortune to see these plants in nature, he has made us acquainted with them as living entities. Now that Dr. Li has returned to China, perhaps across the years he may fill out further and yet more richly the outline that he has presented here.

It is regrettable that lack of space has curtailed somewhat the publication of what Dr. Li has prepared. An " Index to Numbered Collections " is reluctantly omitted, but we are retaining his brief record of collectors of *Pedicularis* in China, which follows immediately.

COLLECTORS OF CHINESE SPECIES OF PEDICULARIS AND THEIR COLLECTIONS

Records of early botanical collectors in China, up to the year 1898, were admirably covered in great detail by the work of Bretschneider.[4] Information concerning these early explorers, such as localities visited, collections taken, etc., which would be otherwise unobtainable or hard to find, is here readily available. No treatise on the work of subsequent botanical collectors has been made. Such a continuation of Bretschneider's contribution is highly desirable, especially as more active and extensive exploration has taken place during the last half century than earlier, and as information concerning botanical collectors of this later period is so scattered. The present list includes workers from more nationalities, and using more different languages, with the entry and active participation in the field of Chinese and Japanese botanists.

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[4] **Bretschneider, E[milii V.]. History of European botanical discoveries in China. i-xv, 1-1167. 1898.**

For a brief summary of botanical exploration in China up to the year 1918, there is an account by Limpricht under the title " Kurzer historischer Überblick über die botanischen und geographischen Forschungsreisen in China und Ost-Tibet " in his narrative of travel in China.[5] The data up to the year 1898 were based on Bretschneider's work. The present writer has written a brief summary on the botanical exploration in China of the twenty-five years from 1918 to 1943.[6] For technical writings and accounts of travels by various collectors in China up to 1936, the reader is referred to Merrill and Walker's extensive bibliography.[7]

The following account mentions briefly the work of each botanical collector whose specimens have been available for the present study. (Because of this limitation, many collectors, who worked in the coastal regions where *Pedicularis* does not grow, are not listed.) Brief notes on the areas visited and the known sources of their collections are given whenever such information is obtainable, though these are only for collections where *Pedicularis* is involved. These brief notes, derived from available literature and herbarium labels, supply the salient facts about both collectors and collections.

Bodinier, Émile. French missionary. Collected in 1880 in Peiping (formerly Peking) and in the regions north of it, and in 1892 and subsequently in Kweichow Province. Collections are in the Paris Museum.

Bohnhof, Hugo. Russian botanist. Collected in 1890-99 in eastern Siberia, and also in Manchuria, especially around the Hanka Lake region.

Cavalerie, A. French missionary. Collected in Kweichow about the years 1905-08.

Chaney, Ralph W. Collected plants in 1925 on Altai mountains in Mongolia with the Third Asiatic Expedition of the American Museum of

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[5] Pp. 1-39 in W. Limpricht's Botanische Reisen in den Hochgebirgen Chinas und Ost-Tibets. In Repert. Sp. Nov. Beih., 12: 1-297. This is the first part of the paper, the second part being a list, by F. Pax, of the species of plants collected; see Bibliography *56*.

[6] Li, Hui-Lin. Botanical exploration in China during the last twenty-five years. Proc. Linn. Soc. London, 156: 25-44. 1944.

[7] Merrill, E. D. & E. H. Walker. A bibliography of eastern Asiatic botany. i-xlii, 1-719. 1938. Arnold Arboretum.

Natural History. Duplicates are at the University of California and the United States National Herbarium.

CHAPMAN, F. SPENCER. Collected in southern Tibet in 1936. Collections are at Kew Gardens, with some duplicates in Gray Herbarium.

CHEN, F. H. Botanist of the Fan Memorial Institute of Biology; specialist on *Saussurea*. Collected in 1931, in Manchuria, particularly in Kirin Province. Some duplicates of his collections are in the Gray Herbarium and the New York Botanical Garden.

CHEN, Y. Head of the Forestry Department of the University of Nanking. Collected in 1926 for the University of Nanking in western Hupeh. Some duplicates of his collections are at the University of California.

CHEO, H. C. Of the University of Nanking. Collected with A. N. Steward and C. Y. Chiao in 1931 in Kweichow Province. See Steward, A. N.

CHEO, S. Y. Of the University of Nanking. Collected with L. Yen in 1936 in Shantung Province under the auspices of the University of Nanking and the Arnold Arboretum of Harvard University. Collections at both institutions.

CHIAO, C. Y. Botanist of the University of Nanking. Collected in 1931, with Steward and Cheo, in Kweichow; in 1936, together with C. S. Fan, on Mount Omei, Szechuan Province; in 1939, in the eastern part of Sikang Province, near Kanting. These expeditions were made in cooperation with the Arnold Arboretum and sets of the collections are also at that institution.

CHING, R. C. Chinese botanist and specialist on ferns. Collected in 1923, as botanist of the National Geographic Society's second scientific exploration in central China, directed by F. R. Wulsin, in northwestern Chinghai, Kansu, and Ninghsia. Collection is in the United States National Herbarium, with duplicates in other herbaria. Collected extensively since 1939 in northwestern alpine Yunnan for the Lushan Arboretum and Botanic Gardens, with the financial cooperation of the Arnold Arboretum. Collections of 1939 are at the last institution.

CHOW, HO-CH'ANG. Collected in 1934 in Hupeh Province for the National Wu-Han University. Duplicates are at the New York Botanical Garden.

CHUNG, H. H. Chinese botanist. Collected in 1923, with S. C. Sun, in Lu-shan, northern Kiangsi, for the National Wu-Han University. Duplicates are at the New York Botanical Garden. Also made extensive collection of Fukien plants from 1922 to 1930 for Amoy University.

CHUNG, N. K. Collector of the Botanical Institute of Sun Yatsen University. Duplicates of his collection made in 1931 in Kwangtung are at the New York Botanical Garden.

CUNNINGHAM, R. Collected around Tatsienlu, Sikang Province, in 1923-24. Some of the specimens are at the Edinburgh Botanic Garden.

CUTTING, CHARLES SUYDAM. British mammalogist. Collected in 1935 in southern Tibet with A. S. Vernay. Collections are at Kew Gardens, with some duplicates in Gray Herbarium.

DELAVAY, JEAN MARIE. French missionary. Collected extensively from 1882 in northwestern Yunnan, with occasional intervals, until his death in 1895. Collections are in Paris Museum. For localities appearing on his labels, see his letter to Bretschneider, in Bretschneider's European Botanical Discoveries in China, pp. 876-883.

DORSETT, P[ALEMON] H[OWARD]. Horticulturist of the Division for Plant Introduction of the U. S. Department of Agriculture. Leader of the expeditions of the Department to China and Manchuria in 1924-27 and 1929-31. Herbarium collections made by him and his son, J. H. Dorsett, are in the United States National Herbarium with duplicates in other herbaria.

DUCLOUX, F. French missionary. Collected in Yunnan Province in the region of "Yunnan sen" (Kunming), around the years 1906-08. Collections are in Paris Museum, with some duplicates in American herbaria.

ERIKSSON, JOEL. Collected in 1924 in Mongolia. Collections are in the United States National Herbarium.

ESQUIROL, J. French missionary. Collected in Kweichow around 1909. Collections are in Paris Museum.

FABER, ERNST. Missionary stationed first at Canton and later at Shanghai. Collected in 1887, in Hupeh and Szechuan. His own collections were destroyed by fire. Duplicates are at Kew Gardens.

FAN, C. S. Botanist of the University of Nanking. Collected with C. Y. Chiao in 1936 on Mount Omei, Szechuan. See Chiao, C. Y.

FANG, W. P. Chinese botanist now of the National Szechuan University. Conducted an extensive botanical expedition in 1928, to western Szechuan for the Science Society of China with the financial cooperation of the Arnold Arboretum. His collections are at those institutions, with some duplicates at the New York Botanical Garden, the United States National Herbarium, etc.

FARGES, PAUL. French missionary stationed in northwestern Szechuan. From 1892 on, he sent to the Paris Museum extensive collections made in that region.

FARRER, REGINALD J. British explorer. Collected extensively in China. Some of the specimens collected in Kansu and Chinghai in 1914 and in Yunnan and Sikang in 1920 are in the Edinburgh Herbarium.

FENG, K. M. Lu-shan Arboretum and Botanic Gardens. Collected extensively in northwestern Yunnan since 1939. Duplicates of collections made in 1929 are in the Arnold Arboretum.

FORREST, GEORGE. British collector. Collected extensively in northwestern Yunnan and southeastern Sikang from 1904 to 1930. Collections are in the Edinburgh Botanic Garden, with many duplicates in the Bonati Herbarium.

FUTTERER, KARL. Collected in Chinghai in 1898. Collections were at Berlin Botanical Garden.

GIRALDI, GUISEPPE. Italian missionary. Collected, from 1890 to 1895, in Shensi Province, especially on the Tai Pai Shan of the Tsinling Range. Collections are in Florence Museum, with some duplicates in the Bonati Herbarium.

HANDEL-MAZZETTI, HEINRICH. Collected extensively in southwestern China during 1914-1918. Collections are at Vienna, with some duplicates in the Bonati Herbarium, the Gray Herbarium, and the United States National Herbarium.

HENRY, AUGUSTINE. Arrived in China and entered the Chinese Customs Service in 1881, first stationed in Ichang, Hupeh. Began collecting plants in 1885, sending his collections to Kew Gardens. Transferred in 1896 to southern Yunnan, where he continued his extensive exploration in and around Mengtze and Szemao. Some duplicates of his collections are in various American herbaria, but especially at the New York Botanical Garden.

HOW, H. C. Collector of the Botanical Institute of Sun Yatsen University. Collected in 1939 around Kunming, Yunnan Province. Duplicates are in the Arnold Arboretum.

HSIA, W. Y. Botanist of the Institute of Botany, National Academy of Peiping. Collected in 1930 in northern Hopei Province. Duplicates are at the New York Botanical Garden.

IKONNIKOV-GALITZKY, N. & V. Russian collectors. Collected in 1926 and 1929 in northern Mongolia. Collections are at the Botanical Institute of the Academy of Sciences of USSR, with some duplicates at the New York Botanical Garden and the University of California.

KING, T. F. Collector of the Fan Memorial Institute of Biology. Collected in 1936 in northern Hopei Province. Some duplicates are at the New York Botanical Garden and the University of California.

KLEMENTZE, ELIZABETH. Wife of D. M. Klementze, Russian explorer. Accompanied her husband, gathering botanical specimens. They collected, around 1896, several times in northern Mongolia. Collections are at Leningrad (St. Pétersburg) Botanic Garden, with some duplicates in the Bonati Herbarium.

KO, S. P. Collector of the Botanical Institute of Sun Yatsen University. Collected in 1933 in Kwangtung. Duplicates are at the New York Botanical Garden.

KOMAROV, V[LADIMIR] L[EONTIEVICH]. Collected in 1896, as botanist of an expedition to explore Manchuria sponsored by the Imperial Geographic Society of Russia. Collections are at the Botanic Garden, St. Pétersburg, with some duplicates at the New York Botanical Garden.

KUNG, H. W. Botanist of the Institute of Botany, National Academy of Peiping. Collected in 1930 in Chahar, and in 1931 in Kirin. Some duplicates of his collections are at the New York Botanical Garden.

LAUFER, BERTHOLD. Collected in 1910 in Sikang for the Field Museum. Collections are at the Chicago Museum of Natural History.

LEE, C. O. University of Nanking. Collected in 1924, with W. D. Lowdermilk, in Shansi. See under Lowdermilk, W. D.

LI, C. F. Collected in 1929 in Hopei for the Fan Memorial Institute of Biology. Some duplicates are at the New York Botanical Garden.

LICENT, ÉMILE. French missionary, of the Musée Hoang-ho Pai-ho of Tientsin. Collected extensively from 1916 to 1937 in various provinces in northern China. Some duplicates of his collections are at the Arnold Arboretum and the Gray Herbarium.

LIMPRICHT, WOLFGANG. Collected extensively in various parts of China in 1911-17. In 1914, explored Szechuan and Sikang, and in 1915-16, Shensi, Shansi, and Hopei in northern China. Collections are in Breslau, with the first duplicate set in Berlin.

LING, K. Of the Forestry Department of the University of Nanking. Collected in Shansi, in 1925, for the herbarium of the university. Some duplicates are at the University of California.

LIOU, T. N. Director of the Institute of Botany, National Academy of Peiping. Collected in 1930, in Hopei. Some duplicates are at the New York Botanical Garden.

LIU, J. C. [JU-CHIANG]. Collected in Hopei, in 1928, for the Peking Union Medical College. Some of the collections were made together with B. E. Read. Some duplicates are at the New York Botanical Garden and the University of California.

LIU, Y. Of the Fan Memorial Institute of Biology. Collected in 1936 in Hopei. Some duplicates are at the New York Botanical Garden and the University of California.

LIU, YU-SHIH. Lu-shan Arboretum and Botanic Gardens. Collected in 1937 on Mount Omei, Szechuan Province. Duplicates are at the Arnold Arboretum.

LOWDERMILK, W[ALTER] C[LAY]. Collected in 1924, some of the specimens together with C. O. Lee, in Shansi, for the herbarium of the University of Nanking. Some duplicates are at the University of California. (Herbarium specimens of the University of Nanking all bear herbarium numbers, which are the numbers here listed in this work. Some of them also bear collector's numbers.)

MACKLIN, DR. American missionary in Nanking. Only one collection, made in 1906, is noted.

MAIRE, E. E. French missionary. Collected extensively around 1920 in northeastern Yunnan and the regions around Kunming. Some duplicates are found in American herbaria. Many collections, especially those made in his later years, and consisting of many unmounted specimens for each, are in the Bonati Herbarium. These evidently were made especially for Bonati and the specimens have probably never been distributed. Their field labels, in many cases, bear dates but without years, and the numbers were invariably added by Bonati.

MEYER, F[RANK] N[ICHOLAS]. Collector of the United States Department of Agriculture. Collected in 1913 in northern China. Collections are in the United States National Herbarium.

MONBEIG, J. T. French missionary. Collected in Yunnan and Sikang around 1908 to 1914. Collections are at Paris and Edinburgh, with some duplicates in the Bonati Herbarium.

PAVLOV, N. V. Collected in northern Mongolia in 1926 for the Academy of Sciences of USSR. Some duplicates are at the New York Botanical Garden.

PENG, T. C. Collected for the West China Union University at Chengtu, on Mount Omei, in 1938. Some duplicates are at the Arnold Arboretum.

POTANIN, GRIGORII NIKOLAEVICH. Conducted many expeditions on behalf of the Imperial Geographic Society of Russia. The first journey, made in 1876-77, and the second in 1879, were both to northwestern Mongolia; the third, made in 1884-86, was to northern and north-western China; and the fourth, made in 1891-94, to Sikang and Szechuan, etc., in western China. His collections were deposited at the Botanic Gardens, St. Pétersburg. Some duplicates are in the Bonati Herbarium.

Pratt, A[ntwerp] E[dgar]. English naturalist. Explored, from 1887 to 1890, the upper Yangtze in Szechuan and Sikang, mainly for zoological specimens. Botanical collections, all made in 1889 to 1890, were mainly around Tatsienlu (Kanting) in Sikang, the plants gathered by native assistant. Collections presented to Kew Gardens.

Przewalski, Nikolai Mikhailovich. Conducted many expeditions to China for the Russian government and the Imperial Geographic Society. In 1870-73, he explored northern China from Peking westward to Kansu and Chinghai (Kokonor). In 1879-80, together with V. I. Roborovski, etc., he collected in Dzungaria and the Tien-shan. In 1883-85, he and Roborovski and others explored the sources of the Yellow River. Collections are at the Botanic Gardens of St. Pétersburg, with some duplicates in the Bonati Herbarium.

Rock, Joseph F[rancis C.]. Collected in 1920-22, for the United States Department of Agriculture, and in 1922-24, for the National Geographic Society, in the northwest and the southern border of Yunnan; in 1924-27, in northwestern China, particularly in Kansu, for the Arnold Arboretum; in 1932-33, in northwestern China, for the University of California Botanic Garden. Collections are in most leading American herbaria.

Schlinder, A. K. Collected in 1907 in Shansi. Collections were at Berlin Botanical Garden, with some duplicates in the Bonati Herbarium.

Schneider, Camillo. Collected in China, mainly in Yunnan, in 1914, as a member of the Austro-Hungarian Dendrological Expeditions. Some duplicates are in American herbaria.

Schoch, O. Collected in Yunnan and Kweichow, in 1916. Some duplicates are in the United States National Herbarium.

Soulié, Jean André. French missionary. Collected in 1890-1903, mostly in Sikang. Early collections are in Paris Museum, with some duplicates in Bonati Herbarium. Many of the later collections were apparently made specially for Bonati, in whose herbarium many unmounted specimens, each in single collections, are found.

Stevens, Herbert. Collected in Sikang, in 1929, with the Kelley-Roosevelt Expedition to Eastern Asia for the Field Museum. Collections are at the Chicago Museum of Natural History.

Steward, A. N. Botanist of the University of Nanking. Collected in 1922, in Lushan, northern Kiangsi; in 1924, in Hwang-shan, southern Anhwei; and in 1931, with Chiao and Cheo, in Kweichow. Some duplicates are in several American herbaria.

Stewart, H. M. Collected in southern Tibet. Collections are at Calcutta.

STÖTZNER, W. Collected in 1928 in Manchuria. Collections were at Berlin Botanical Garden, with some duplicates at the New York Botanical Garden.

SUN, S. C. Collected, in 1923, with H. H. Chung, for the National Wu-Han University, in Lushan, northern Kiangsi.

TANG, T. Botanist of the Fan Memorial Institute of Biology, and specialist on the Monocotyledons. Collected extensively in Shansi in 1929, covering most of the important mountain ranges of the province. Duplicates are at the New York Botanical Garden.

TEN, SIMEON. Chinese catholic priest in Yunnan, where he collected plants about 1920. Collections are mostly in the Paris Museum, with some duplicates in the Edinburgh Herbarium.

TSAI, H. T. Botanist of the Fan Memorial Institute of Biology. Conducted extensive explorations, from 1932-34, in northwestern Yunnan for the Institute and the Arnold Arboretum. Set of duplicates in the latter institution.

TSANG, W. T. Collector of the Lingnan University herbarium. Conducted extensive survey in Kwangtung, Hainan, Kwangsi, and Indo-China, from 1922 to 1940. Duplicates are at the New York Botanical Garden and the Arnold Arboretum.

TSIANG, Y. Botanist of the Botanical Institute of Sun Yatsen University, and specialist on the Asclepiadales. Collected in Kweichow in 1930-31 and in Kiangsi in 1932 for the Academia Sinica. Duplicates are at the New York Botanical Garden.

TSO, C. L. Collected in 1929, in Kwangtung, for the Botanical Institute of Sun Yatsen University. Duplicates are at the New York Botanical Garden.

TSOONG, K. K. Late professor of the National Peking University, and a pioneer botanical collector. Began his collecting in 1908 in Kwangtung, later collecting in many other provinces, including Yunnan. Few of his specimens are available in the United States, but some are at the University of California.

VERNAY, A. S. Collected in southern Tibet in 1935 with C. S. Cutting. See under Cutting, C. S.

WANG, C. Collector of the Botanical Institute of Sun Yatsen University. Collected in 1931 in Kwangtung. Some duplicates are at the New York Botanical Garden.

WANG, C. W. Botanist of the Fan Memorial Institute of Biology. Conducted extensive exploration, from 1935-36, in alpine northwestern Yunnan and adjacent southern Sikang for the Institute and the Arnold Arboretum. Duplicates are at the latter institution.

WANG, F. T. Botanist of the Fan Memorial Institute of Biology, and specialist on the Monocotyledons. Collected in 1931 in western Szechuan for the Institute and the Arnold Arboretum. Duplicates are at the latter institution.

WANG, H. Collector of the Botanical Institute of Sun Yatsen University. Collected in 1933 in Yunnan. Duplicates are at the Arnold Arboretum.

WANG-TE-HUI. Collected plants for Handel-Mazzetti around 1919 in Hunan Province. Some of the duplicates are in the United States National Herbarium.

WANG, T. K. Collected with T. S. Wen in western Szechuan and eastern Sikang, in 1938, for the Western China Union University. Duplicates are at the Arnold Arboretum.

WANG, T. P. Botanist of the Institute of Botany, National Academy of Peiping. Collected in 1931, in Hopei. Some duplicates are at the New York Botanical Garden.

WARD, F[RANCIS] KINGDON. Conducted extensive explorations in Yunnan, Sikang, and Tibet, from 1912. Collections mostly at Kew Gardens but some duplicates at Edinburgh have been studied. No specimens of Chinese *Pedicularis* from his collections are available in American herbaria.

WEN, T. S. See Wang, T. K.

WILFORD, CHARLES. Collector for the Kew Gardens. Collected in 1857-59, in various places on the coast from southern China, Formosa, Manchuria, to Korea and Japan. Collections are at Kew Gardens, with some specimens in the United States National Herbarium.

WILSON, ERNEST H[ENRY]. In his early trips to China, devoted to horticultural collecting for J. Veitch & Sons, of London, England, herbaceous as well as woody specimens were gathered. From 1901 to 1903, he traveled and collected through western Hupeh to Szechuan and Sikang. Some specimens were presented by Veitch to the New York Botanical Garden and the United States National Herbarium. Many duplicates are also in the Bonati Herbarium, obtained from Kew.

YEN, L. See Cheo, S. Y.

YIN, K. N. Collected in 1938, on Mount Omei, Szechuan, for the West China Union University. Duplicates are in the Arnold Arboretum.

YÜ, T. T. Botanist of the Fan Memorial Institute of Biology. Conducted extensive explorations in northwestern Yunnan in 1937-38 for the Institute and the Arnold Arboretum. Duplicates are at the latter institution.

TAXONOMIC POSITION

The genus *Pedicularis* belongs to the tribe Euphrasieae, a most natural tribe occupying the highest position in the Rhinanthoid subfamily of the Scrophulariaceae. The tribe comprises about 20 genera distributed throughout the cooler zones of the earth but is most numerous in both genera and species in the colder regions of the northern hemisphere. The genera more closely related to *Pedicularis* are *Melampyrum, Phtheirospermum, Euphrasia, Bartsia,* and *Siphonostegia.* Of these *Phtheirospermum* and *Siphonostegia,* occurring in western China and the eastern Himalayas, resemble some species of *Pedicularis* in general appearance.

MORPHOLOGY

Root or rhizome.—In general, the species of *Pedicularis* are semi-parasites. The majority of them are perennials. The roots are usually woody, with either fibrous or tuberous rootlets. Often a rhizome is developed that is thick and fleshy, either erect or horizontal, and branched or unbranched. Sometimes it is crowned with membranaceous scales, these being transformed petioles.

Aerial stem.—In general there is a distinct stem, sometimes very short, but usually elongated, at times exceeding one meter in length. It may be straight and upright, or sometimes trailing and diffuse. It is either rounded and smooth, or sometimes grooved. It may be simple or branched, the branches, like the leaves, being opposite, verticillate, or alternate. The branching may occur at base or toward the summit of the plant, with the branches either simple or repeatedly branched, and either fastigiate or spreading.

The stem and branches are usually hairy, but sometimes they may be glabrous or nearly so. The pubescence varies from villose to hirsute, and is sometimes glandular. The hairs often appear in vertical lines corresponding to the number of leaves in a node.

Leaves.—The leaves may be basal or cauline. The basal or radical leaves later disappear in some species but persist in others. The cauline leaves may be opposite, whorled, or alternate. They may be very abundant or few in number, or even, in occasional species, nearly absent. They are similar to the radical leaves in some species, or similar in shape but smaller and with shorter petioles or sessile in others, or entirely different in form in still others. The petioles are variable in length; sometimes they are slightly or strongly winged, in a few species being enlarged at base and widely connate. The leaf-blades vary considerably in shape, from ovate to lanceolate. Their texture varies from thin-membranaceous to thick-chartaceous. They are either glabrous or else covered with hairs, which differ specifically in length and density. The leaf-margins are rarely subentire, being usually serrate, crenate, pinnatifid, or pinnatisect, and often twice- or thrice-divided.

Inflorescences.—Flowers may be scattered throughout the length of the stems, but usually they form definite inflorescences toward the end of the stem or branches. They may be sessile and subsessile or pedicellate, thus forming subcapitate or spicate or racemose inflorescences. Bracts are usually similar to the leaves, but are smaller and mostly sessile. The upper bract may be more different but the lower ones are often transitional from the leaves.

Calyx.—The calyx consists of a tube varying from ovoid-campanulate to cylindric, bearing distally 2 to 5 teeth. It may be membranaceous or chartaceous, glabrous or hairy. It is usually longitudinally 5-nerved, with or without intermediate slender nerves or reticulations. It is either entire or cleft anteriorly. In non-cleft calyces, the teeth are often 5 in number, either similar or with the uppermost one smaller. In cleft calyces, the cleft may be shallow or deep, the teeth varying from 5 to 2. The general tendency is to reduction in number of teeth. From 5 teeth of equal size, the number is reduced to 4 by diminishing in size and final disappearance of the posterior or uppermost tooth. The two lateral teeth on each side may be united or the anterior or lowest may diminish in size or disappear. The result will be either a 3-dentate calyx when the posterior tooth is still present or a 2-dentate one when the latter is non-existent. The shape of the teeth varies considerably. In some these are rounded or deltoid, with the base broader than the apex. In others they become ovate to lanceolate, sometimes considerably narrowed below and thus stipitate. They vary from entire to crenate, serrate, or even pinnatisect.

Corolla.—The corolla consists of a basal tube and of two distal lips. The upper lip is a compressed hood (galea) containing the anthers and styles and it is sometimes prolonged into a beak. The lower lip is spreading and trifid. In the bud, the galea is inmost, covered by the lower lip with its middle lobe outermost.

The tube varies considerably in length. In some species, it is short, being either shorter than the calyx or slightly exceeding it. It may be curved or straight. It generally enlarges distally. The filaments of the stamens are usually attached to the base or the middle of the tube. The tube is often slightly twisted. In other species, the tube is slender, of the same caliber throughout, and much elongated, sometimes to over ten times as long as the calyx. In these long-tubular species, the stamens are usually attached to the throat of the tube.

The lower lip is 3-lobed, usually broader and rounded in front. In some species, it is sessile, and in others, more or less stipitate with ridges near the base of the lobes. The lobes are usually rounded but sometimes acute, with entire or sometimes fimbriate margins, these being either glabrous or finely ciliate. The three lobes are either equal or unequal in size, in the latter case the middle lobe being often larger and more distad. The lip is often bilaterally unsymmetrical, being shorter and slanting toward one side.

The basal part of the galea, being the part contiguous with the tube, is usually erect and of the same width or sometimes slightly larger. It is generally of the same length as the distal part, which encloses the anthers. The distal part is usually of thicker tissue, and generally it is wider. It may be erect or more often either curved or angularly bent. The margin is usually slightly thickened, sometimes toothed and sometimes long-hairy. In some species it is toothed immediately below the apex, while in others the apex is prolonged into a beak. Such a beak may be short and thick or slender and falcate, straight or coiled, with the apex entire or bifid. The beak, and sometimes the galea, often twist slightly or strongly toward one side.

The dorsal side of the galea is normally smooth, but in some species a crest is present. Usually it is a low ridge formed along the median dorsal line in the front of the galea. Sometimes it becomes rather prominent with a raised front which is either acute or crenate. In a few cases, it projects into a long narrow pointed process almost equaling the beak in length.

The twisting of the corolla, including the tube, the galea, and the beak, as well as the lower lip, has been noted in many species by authors such as Steven, Maximowicz, and Prain. While this is not a complete resupination, the twisting is very profound and conspicuous in some species. In others the twisting involves only the slight turning of the tube or the slanting of the lower lip, which can not always be definitely made out in dried pressed specimens. But twisting of either the beak or the galea is often distinctly marked. Field observation is necessary to determine the constancy of this phenomenon and its significance.

The color of the corolla is either yellow (from greenish to deep yellow) or else purple (from rose and pink to reddish purple). From both colors white may develop. Some species have the proximal portion yellow and the distal portion purple, while others are yellowish throughout but spotted red or purple distally.

Stamens.—The stamens are attached to either the base, the middle, or the apex of the corolla-tube. In the long-tubular forms, they are invariably attached to the apex. The filaments are narrow and with a main vein. They may be glabrous or hairy, the pubescence being limited to the base, scattered through the whole length, or, more usually, developed toward the distal portion. If only one pair of the filaments is hairy, it is always the anterior pair. The anthers are free and parallel, contiguous or apart, and usually obtuse but sometimes sharply pointed at the base.

Carpel.—The ovary is 2-celled, ovoid or lanceolate in contour and usually slightly oblique. The style is proximally erect, then curves toward the dorsal side of the tube and thence follows the curvature of the tube and the galea. The stigma is sub-capitate, sometimes being included in the galea but more generally exserted.

Capsule.—The capsule varies in shape and size, but is constant in each species and often among related species. It is usually compressed-ovoid to lanceolate, or else may be subglobular. The apex may be long and acuminate or short and acute, and is distinctly or indistinctly oblique. The dehiscence is loculicidal, splitting distally, either on the dorsal side only or else on both the dorsal and ventral sides.

Seeds.—The seeds vary greatly in number, size, form, color, and surface-markings. These are usually constant in each species. The number varies from 20 to as few as 3 or 4 in each cell. In size they range from ½ mm. to 4 mm. in length, being in form from spherical or ellipsoid to nearly fusiform. The color varies from pale grey to black. The markings on the surfaces vary from all patterns between longitudinal striations to deep pits. Though the seed character would be useful in specific differentiation, the absence of fruit in most herbarium specimens prevents the use of this character in the present study.

CLASSIFICATION

Diagnosis and Classification of Species

The foregoing summary of the morphology of the genus also indicates the diagnostic characters of the species. Only a few of these are widely distributed, most of them being endemic to a very limited area. In most cases, they are well marked with distinct characters, readily distinguished from their relatives. Species of close relationship often have very similar vegetative characters, such as general habit, roots, stems, leaves and pubescence. These characters are, thus, less useful in diagnosing species than floral characters, but the detailed features of the leaves, such as shape, size, serrations, etc., are often of considerable importance.

In the arrangement of the flowers, closely related species do not differ much from each other. Often the length of the pedicels and the size and shape of the bracts can be used in specific diagnosis. The calyx, while usually similar in related species, shows important differences within the genus. The texture, size, pubescence, venation, and the number and structure of the teeth may be employed in distinguishing species. The most important characters of all are those of the corolla. Size, general shape, hairiness, length of tube, curvature of galea, length and shape of the lower lip, length and shape of the beak, if present, and all accessory structures that may be developed on the corolla, are all of prime importance in specific diagnosis. The lower lip varies considerably in relative size, position, and shape of the lobes, hairiness on the margins, etc. These differences are usually constant in different species. The stamens are also important, especially with regard to the place of their attachment to the tube, the hairiness of the filaments, and sometimes the location and shape of the anthers. The location of the stigma, either included in the corolla or exserted, may be sometimes used. The structure of the capsules is usually similar in related species. The structure of the seed is also a useful specific character, but seeds are usually not available because fruits are so seldom collected.

Under the species, especially the more widely distributed ones, various subgroupings may be sometimes recognized, these being usually geographically distinct but contiguous. They are named subspecies or varieties, and whenever such are present, the typical form of the species as originally described, is here given the name " typica," all being considered as of equal rank. For ordinary usage, when a species is mentioned by itself, the term " typica " is not necessarily mentioned, the word being used only in distinguishing it from its varieties. But a subspecies or variety " typica," whenever it has been formally named and described by previous authors, is here duly cited as such.

Diagnosis and Classification of Series and Higher Divisions

The species of *Pedicularis* fall into very natural groupings designated by various authors as " series." Each of these consists of species that agree in general characters such as habit, roots, stems, leaves, and inflorescences. The fundamental structures of the calyx and corolla are also similar. The capsules are almost identical. These series are usually clearly defined and readily recognized. And yet, as mentioned before, the individual species that comprise a series, are also usually clearly marked.

The significance of these series as taxonomic units in *Pedicularis* was fully appreciated by Prain (75), who recognized 84 such in the genus. Well-defined series are accepted by most authors and these will undoubtedly serve as bases of the classification of the genus also in the future. However, the grouping of these series into higher divisions is a difficult problem. The proposed systems do not agree with each other, and neither are they satisfactory from a phylogenetic point of view. The chief characters employed are the structure of the corolla, with phyllotaxy as subordinate. There are four types of corollas, the toothless, the toothed, the beaked, and the long-tubed. While groups based upon these may be conveniently used for identification purposes, they prove to be artificial, rather than natural.

As shown below, parallel evolution is a common phenomenon in the development of the various types of corollas in *Pedicularis*. Thus, two species with the same type of corolla may have entirely different structures in other respects and have clearly been evolved from remote stocks. On the other hand, very closely related species may be placed in widely separated groups simply because of having two different types of corollas. It is evident, that a system based primarily on the types of corolla will obscure the real kinship of some of the species.

A review of the existing systems of classification is given below. After a study of the genus as a whole, and the Chinese species in particular, it is felt that these systems should be abandoned. A new system, based on obvious kinships among the series, is herein proposed and outlined.

Proposed Systems of Classification

Earlier Systems

Linnaeus (61) and Willdenow (89) had only a few species and they arranged them according to characters derived from habit. Steven (86) was the first to propose a system of classification with 6 divisions which he named as tribes. His system is necessarily inadequate for present-day use as he knew only 49 species. He used both phyllotaxy and characters of the corolla in defining his primary divisions. His tribes are characterized as follows:

Tribe 1. Personatae: Leaves opposite or alternate; lower lip erect.
Tribe 2. Verticillatae: Leaves 4-verticillate.
Tribe 3. Faucidentates: Leaves alternate; galea dentate at base.
Tribe 4. Rostratae: Leaves alternate; galea beaked.
Tribe 5. Bicuspidatae: Leaves alternate; galea bidentate at apex.
Tribe 6. Edentulae: Leaves alternate; galea edentate at apex.

Notable is the fact that he recognized, among others, the Verticillatae, basing it on characters derived from habit, while in all the other divisions he used characters derived from the structure of the corolla. Prain, in 1890, remarked that " It is somewhat curious that while the other five tribes have been recast and modified so that only the outline of one (*Rostratae*) has been retained, and not one of them even in name continues as a primary division, the *Verticillatae* have continued in every subsequent revision of the genus to hold primary rank and to retain the original or an equivalent name." Prain thought that this division also should be abandoned. Subsequent authors, however, such as Bonati and Limpricht, again used phyllotaxy as a major character for their systems. As discussed in detail elsewhere, phyllotaxy in *Pedicularis* is a fundamental character for forming natural groupings. Steven is thus to be commended for his early recognition of this character.

The systems of Bentham in 1835 (1) and in 1846 (3), and of Bunge in 1846 (28) made no great improvement over that of Steven. Bentham added the "Siphonanthae" which was considered by later authors to be a natural group and has remained in most systems.

The System of Maximowicz (1888)

Maximowicz in 1888 (66), with 250 species known to him, made the first extensive classification of the genus. He divided it into 5 tribes and 27 series. The tribes, arranged progressively from the most to the least specialized, are characterized as follows:

Tribe I. Longirostres: Corolla-tube cylindric, often elongate; galea usually with long beak, rarely beakless; leaves alternate or verticillate. This tribe is subdivided into 1. Siphonanthae
2. Longirostres verticillatae.

Tribe II. Rhyncholophae: Corolla-tube cylindric, dilated distally; galea beaked, rarely beakless; leaves alternate.

Tribe III. Verticillatae: Corolla variable, the galea not beaked; leaves verticillate or opposite.

Tribe IV. Bidentatae: Galea beakless or with short and broad beak, the margins bidentate near the apex; leaves alternate.

Tribe V. Anodontae: Galea beakless, the margins usually edentate or rarely and inconstantly bidentate; leaves alternate.

Maximowicz's system, as compared with that of Steven, shows an apparent improvement in the clearer recognition of the various types of corolla. His tribes, except the Verticillatae, represent the four main forms of corolla: the long-tubed, the beaked, the toothed, and the toothless. This system of division has been followed by subsequent authors in the main outline, and it is, though artificial, nevertheless a convenient means for the identification of the plants.

Maximowicz retained the Verticillatae of Steven. In this group, he used phyllotaxy as the basic character in contrast with the other groups which were founded on characters derived from corolla structures. He placed in this tribe species with various kinds of corollas with the exception of the long-beaked and the long-tubular ones which he put in the Longirostres. This inconsistency in the system was open to criticism by Prain and Bonati.

The System of Prain (1890)

Prain (75) revised the genus two years after Maximowicz, and he had 270 species at his disposal. He divided the genus into 3 main divisions and 5 tribes, comprising 84 series. His system, arranged progressively from the more specialized to the less specialized groups, is as follows:

Division I. Longirostres: Corolla-tube straight, slender, uniform; galea long-beaked.
  Section 1. Siphonanthae: Corolla-tube usually much elongated; leaves mostly alternate.
  Section 2. Orthorrhynchae: Corolla-tube much shorter; leaves verticillate.

Division II. Aduncae: Corolla-tube curved, cylindric, slightly enlarged distally; galea beaked or beakless.
  Section 3. Rhyncholophae: Galea beaked or sometimes beakless.
  Section 4. Bidentatae: Galea beakless or short- and wide-beaked, always 2-dentate immediately below the apex.

Division III. Erostres: Corolla-tube infracted, infundibuliform; galea beakless.
  Section 5. Anodontae: Galea erect, beakless or with very short rudimentary beak, edentulous or only toothed at the lower angle, the apex always rounded.

Prain's system is characterized by his emphasis on the corolla-characters only, neglecting the leaf-arrangement. After lengthy discussions, he reached the conclusion that, " though the primary division based on the constant possession or the reverse of whorled or opposite leaves is a highly natural one," phyllotaxy, " except in the formation of artificial keys to species, must take a subordinate position." He used, instead, with considerable emphasis, the shape and texture of the lower corolla-lip, a character which is most inconstant and unconvincing and which is thus omitted from the table above. He also deliberately united the verticillate- and alternate-leaved species in both the " Bidentatae " and the " Rhyncholophae," and combined these two to form the new group " Aduncae." His arrangement was criticized by Bonati as being illogical and has not been followed by later authors.

On the whole, Prain's system, although made subsequent to that of Maximowicz, is less to be commended. He made detailed analyses on various points of phylogenetic significance, but, apparently due to his overemphasis of the desirability of the abandonment of the phyllotaxy character, his final decisions were often contrary to their logical conclusions. Prain's real contribution was his clear understanding of the concept of the " series," of which he clearly defined eighty-four in the genus *Pedicularis*. These are the " units " of classification in the genus. Much remains to be known in morphology, cytology, genetics, distribution, etc., before a real phylogenetic arrangement of the genus can be made, and such a system has to be based primarily on the clearer recognition of these series.

The System of Bonati (1918)

Bonati in 1910 (11) proposed to divide the genus into 2 main divisions, 4 tribes, and 8 sections. Revised in 1918 (19), with a few changes in the names, his system, arranged from the more primitive to the more specialized groups, is as follows:

Division I. **Erostres**: Galea beakless.
  Tribe I. Anodontae.
    Section 1. Anodontae alternifoliae. Leaves alternate.
    Section 2. Anodontae verticillatae. Leaves verticillate.
Division II. **Rostratae**: Galea beaked.
  Tribe II. Bidentatae. Corolla-tube generally dilated distally; galea bidentate on the margins near the apex.
    Section 3. Bidentatae alternifoliae. Leaves alternate.
    Section 4. Bidentatae verticillatae. Leaves opposite or verticillate.
  Tribe III. Rhyncholophae: Corolla-tube dilated distally; galea with the margins entire.
    Section 5. Rhyncholophae alternifoliae. Leaves alternate.
    Section 6. Rhyncholophae verticillatae. Leaves opposite or verticillate.
  Tribe IV. Longirostres: Corolla-tube cylindric, not dilated above; galea with margins entire.
    Section 7. Siphonanthae: Leaves alternate.
    Section 8. Orthorhynchae: Leaves verticillate or opposite.

Bonati remarked that phyllotaxy is more important than corolla-character in the classification of the genus although in his actual system he still treated it as subordinate to the latter. However, he first gave due emphasis to this point and consequently his system is a marked improvement over that of Prain. He recognized clearly that in every type of corolla a verticillate-leaved group is to be distinguished from an alternate-leaved one.

The System of Limpricht (1924)

Limpricht in 1924 (58) followed essentially Bonati's classification with only slight changes in arrangement. He enumerated 416 species for the whole genus, comprising some 65 series.

A. Erostres.
  I. Anodontae alternifoliae.
  II. Anodontae verticillatae.
  III. Bidentatae alternifoliae.
  IV. Bidentatae verticillatae.
B. Rhynchophorae.
  V. Rhyncholophae alternifoliae.
  VI. Rhyncholophae verticillatae.
  VII. Longirostres Siphonanthae.
  VIII. Longirostres Orthorhynchae.

Notes on Phylogeny and a New System of Classification

Existing systems of classification are to be criticized for their undue emphasis on the various forms of the corolla as being fundamental to classification. They neglect entirely the fact that parallel evolution accounts for these forms and consequently that systems built primarily upon them do not show the underlying phylogenetic divisions of the genus. In *Pedicularis* any system based simply on obvious structures of the corolla is artificial. It may be convenient for purposes of identification, but it obscures the true relationships among the species. A study of the phylogenetic trends of the genus has resulted in the conclusion that the existing systems of classification must be abandoned. Therefore, a new system is here proposed that attempts to give due emphasis to what is believed to be the natural relationship of the various groups. A summary of the study is presented below.

The genus *Pedicularis,* with its large number of species showing endless variations in the corolla-structures, is evidently a young one. The different species have remarkable potentiality, inherent in the genus as a whole, to be able to respond to their insect-pollinators in the shaping of their corollas. While many of the species can be pollinated by bees in general, others with highly specialized beaked or long-tubed corollas apparently require specific pollinators in the form of certain species of the Lepidoptera or other insects. Their existence, therefore, depends to a very great extent on the presence or absence of these special insects.

The large number of locally endemic species seems to testify to the obligatory requirement of the insect-visitors of many of the species. Together with the semi-parasitic habit and the restricted alpine environments, this accounts for the limited dispersal of many of the species. If a particular insect-visitor disappears for some reason, it is quite possible that some highly specialized species of *Pedicularis* depending solely on it for pollination will also become extinct. Many species may have appeared and disappeared in relation to the change of the insect fauna. Also, evidently the process of multiplication of the species in the genus, which may be caused by mutation, hybridization, polyploidy, or other means, is still actively going on, especially in the alpine regions. There is evidence that the two different species of unrelated stocks may have developed in the same, or sometimes in different regions, both of them showing a similar form of corolla in response to the same or similar insect-pollinators. And there is also evidence that one species may give rise to another with like vegetative characters but with a different form of corolla induced by the presence of a new insect-visitor.

In the first case we may cite as examples the presence of beaked as well as beakless and of long-tubular as well as short-tubular species in widely separated areas and also among both verticillate- and opposite-leaved groups. Thus *Pedicularis integerrima,* which has a long-beaked corolla resembling that of *P. polyphylla* and which may be visited by the same or similar kinds of insects, has an entirely different habit, showing that the two are only remotely related. *P. muscicola* has a very specialized flower with a long slender corolla-tube and a distinct beak. Its pollination is evidently limited to certain groups of insects only. *P. sigmoidea* has a similar corolla, but shows not only a very different habit but also a range remote from the other.

On the other hand, many illustrations can be used to show independent development of similar corolla transformations. *Pedicularis dichotoma* and *P. pentagona* have very similar vegetative characters as well as calyx-structures. In fruiting specimens, the two are almost indistinguishable. Yet the corolla of one is beakless and the other distinctly beaked. Except for the corolla, their remarkable similarity indicates very obviously their intimate relationship. Illustrations showing this kind of paired species, a beakless and a beaked one of similar vegetative characters, can be easily multiplied. A very specialized structure of the corolla of some of the species is the crest on the galea. While the crest is usually in the shape of a ridge, in some cases this is modified into a long, slender, pointed structure simulating somewhat an additional beak and giving the faulty impression of the beak being totally bifid. This very peculiar structure has been found in three instances. In each case, it occurs on a plant otherwise similar to a related species without such a structure. The plants with this appendage are invariably recognized as varieties of the species that lack it. Thus we have *P. mussoti* and its var. *lophocentra, P. cranolopha* and its var. *longicornuta, P. siphonantha* and its var. *birmanica,* three unrelated sets of plants. Clearly this pointed crest has been developed in each case separately and independently for performing some special and possibly similar function that is yet unknown.

Probably the most convincing illustration showing the independent evolution of the corolla-types is the "Superbae" group of *Pedicularis.* It is recognized by all authors as a series with very coherent characters. The species comprising this group are remarkable in the genus in that their leaf-bases or bracts enlarge and are connate into cup-like structures. They represent a clearly distinct and homogenous line of evolution. Yet in this group we find species possessing all the fundamental forms of corolla that are present in the genus. *P. rex* has a bidentate galea. *P. cyathophylloides* has a toothless or obscurely dentate galea. *P. superba* has a galea ending in a long distinct beak. And finally *P. cyathophylla* has not only a beak but also a greatly elongated cylindric corolla-tube. However, in spite of these specialized corollas, no author has attempted to split the group in order to fit the species into his system based on the different forms of corolla. For instance, in Limpricht's system, the series "Superbae" occupies the awkward position of remaining in the "Bidentatae verticillatae" in spite of the fact that it equally deserves a place in 3 of his other divisions, "Anodontae verticillatae," "Rhyncholophae verticillatae" and "Longirostres Orthorrhynchae."

The above instances show that corolla-forms have been developed independently, and in parallel lines of inheritance, so must not be used indiscriminately as basic units for classification. It becomes evident that leaf-form is a more conservative character in *Pedicularis* and consequently can be better used as a basis for larger groupings of species. This is comprehensible since the leaves have been subject to less environmental stimulation than the corolla, and are thus less variable and more constant. In *Pedicularis*, related species mostly show similar vegetative characters, not only in the arrangement of the leaves, but also in their shape and texture. Considering the fact that most species have a similar alpine habitat, it is but natural to find that groups of species of related stocks and inhabiting more or less contiguous areas will bear similar types of leaves. Although we do not rule out the possibility of parallel evolution in vegetative structures, it is safe to conclude that its chance is much smaller than in the case of the corolla. Thus a major cleavage of the genus based on the leaves should be more phylogenetically reliable than one based on the forms of the corolla.

There are two main types of leaf-arrangement, verticillate or opposite, and alternate. In the Scrophulariaceae in general, opposite leaves often occur in groups, that on other evidence, appear to be more primitive. (Also the first leaves, cotyledons, of all Dicotyledons are always opposite.) Thus opposite-leaved species are to be considered as more primitive than alternate-leaved ones. The verticillate-leaved condition is found exclusively developed only in obviously ancient genera. Thus, in *Pedicularis* it is closely associated with the opposite-leaved condition, to which it is related, while it is evidently more primitive than the alternate-leaved state. Among the opposite- and the verticillate-leaved species, we find that most of them have the more archaic beakless and short-tubed corolla, while among the alternate-leaved species occur most of the more specialized long-tubular and long-beaked corollas. Geographically, the opposite- and verticillate-leaved species are predominantly of the Old World, with just a few species extending to Alaskan America, while the alternate-leaved species are more widespread. They are not only found in the New World, but are also of wider range in the Old World. As the origin of the genus is certainly in the Old World and probably in central Asia, it may be suggested that alternate-leaved species were derived later than, and from, the opposite-leaved ancestry, and that with the elevation of the mountain ranges and cooling off of the climate in both hemispheres, they have been able to populate more rapidly areas newly opened to the genus.

Phyllotaxy, however, is not a sharply delimited character in the genus, and, though it can be used for major sub-generic divisions, these cannot be considered as subgenera according to ordinary usage. Three groups are distinguishable, which may be named " greges." The first group consists of species with strictly opposite or verticillate leaves. Their flowers are always opposite or verticillate and arranged in definite terminal spikes or racemes.

The second group comprises alternate-leaved species. The flowers are alternately arranged and also form terminal inflorescences. The third group contains species that have essentially alternate but more or less irregularly arranged leaves. Among these, usually alternate, opposite, or subopposite leaves occur on the same plant. The stems are slender, usually trailing, and the flowers, usually long- and slender-pedicelled, are axillary and scattered throughout the whole length of the stem.

In each of these groups, different lines of evolution are apparent. Series of similar fundamental vegetative and floral characters can be grouped into "sections." Oftentimes various types of corollas are found in the same section. The sections therefore show different lines of evolution, and in each the corolla may reveal evolution from a simple to a highly specialized condition. Thus, in various sections, the corolla evolution repeatedly culminates in the development of long beaks and long tubes. Altogether, for the Chinese species, 22 sections are recognized. A synopsis of the various series, sections, and groups of *Pedicularis* in China is given in the systematic treatment. A diagrammatic scheme showing the relationships of the various series and sections is given in three tables for the three groups. The various types of corollas found in each of the series are indicated in the left column, so that attainment in corolla specialization for each of the groups can be detected. The tables also serve to illustrate the older systems of classification, these showing between the horizontal lines the various forms of corollas, while the new system now proposed shows in the vertical divisions the various lines of evolution in the genus.

Among the four forms of corollas, the toothless and the toothed ones are evidently the more archaic, while the beaked and the long-tubed ones are derivatives from them. The long-tubular ones are invariably also beaked, and these are clearly derived from beaked ones with shorter corolla-tubes. In regard to the toothless and toothed forms, however, it is difficult to state which is the more primitive. In some cases, the toothless species of a given group appear to be the stock from which the toothed forms have been derived, while in others the teeth are clearly rudimentary and are not derived structures. Thus although the toothed forms are listed in the diagram above the toothless ones, it does not mean that they are necessarily the more specialized. Beaked corollas are apparently evolved from both toothed and toothless ones as both conditions may be carried into the beaked state. Teeth may be present in some species where a very short beak is developed, but they are very rare in corollas with long beak. The four forms of corollas do not exist as clear-cut groups; intermediate species with corollas between the toothless and beaked, toothless and toothed, toothed and beaked, and short- and long-tubed conditions are numerous. This fact further testifies to the gradual and continuous changes that have occurred in the evolution of the various forms of corollas in repeated lines of development in the genus.

HYBRIDIZATION

The problem of hybridization in *Pedicularis* offers an interesting subject for study. Bonati (19) believed that hybridization is an important factor in the evolution in the genus and made an intensive study of European species in which he recognized no less than 32 species as hybrids. No such study has been made of Asiatic species. The only Chinese species that has been described as a hybrid is *P.* × *wettsteiniana* Bonati of the Tali Range, Yunnan, doubtfully supposed by its author to be a hybrid of *P. brevifolia* Don × *P. porrecta* Wall. But these two are Indian species, and in this study, it is shown that the Chinese plants so referred are actually *P. verbenaefolia* Franch. and *P. villosula* Franch., respectively. Bonati's supposed hybrid appears to be a smaller-leaved form of *P. verbenaefolia.*

Bonati was of the opinion that among the Himalayan and western Chinese species of *Pedicularis,* the number of hybrids may be considerable when these are better understood, as he maintained that the cause of hybridization for the European species must be equally existent there while the numbers of species and of series are much larger than in Europe. The problem, however, cannot be studied with confidence until actual observations are made in the field. Occasionally among herbarium specimens a species may be noted with intermediate characters between two other species and this leads to the suspicion that it may possibly be a hybrid between them. However, not being substantiated by distributional and ecological evidence, it is considered unwarranted to draw such a conclusion now. Hence, for all described, and herein newly proposed species, hybrids are not specifically recognized or indicated. As most species of *Pedicularis* are found in remote and nearly inaccessible alpine-montane regions, a detailed field study of the subject would be most difficult. Difficulties in the study of hybridization in the genus are further augmented by the fact that most species of *Pedicularis* are semiparasitic and exceedingly hard to cultivate. Thus studies in genetics and cytology in the genus present some most troublesome problems.

POLLINATION

The exceeding diversity in the form of the corolla in *Pedicularis* is likely unequaled in any other genus of flowering plants. Unquestionably such interesting transformations correlate directly with the process of pollination. This genus thus offers a most unique problem for field study. A better knowledge of the pollination of the genus, especially among the highly specialized species in the Himalayas and western China, will not only add to our understanding of the phylogeny of the genus, but will probably also throw some light on the problem of speciation in the flowering plants in general.

Knuth[8] summarized the observations made by various authors on the pollination of various common European species. Some of these species, such as *Pedicularis palustris, P. verticillata, P. sceptrum-carolinum,* etc., extend also to Mongolia and northern China. They are mostly short-tubular and short-beaked species. The pollinators, as observed, are mostly bumblebees, but also some butterflies and moths. Self-pollination, as observed by some authors, is rare or could be effected only with difficulty.

No studies of pollination have been made on Asiatic montane species. While it is undoubted that bees play an important role in the pollination of most species in this area, probably assisted by other insects to some extent, the long-tubular species apparently must be pollinated by the Lepidoptera. Collectors frequently noted the brilliant view displayed by large colonies of brightly colored species of *Pedicularis* in the highest meadows on these mountains. Butterflies and moths are also known to be abundant there. The lengthy narrow tube of some of the species undoubtedly requires some lepidopterous insects with extremely long proboscises as its visitors.

No other areas of the world show such diversified forms of corolla in this genus as do the eastern Himalayas and mountains of western China. Highly specialized forms have extremely long and slender corolla-tube, together with a long and slender beak. The beak is sometimes strongly twisted to one side. In some flowers, a long slender process grows out of the dorsal side of the galea with the result that the galea has seemingly two long beaks, one above the other. The development of all these highly modified structures must be associated with pollination mechanisms that require special insects.

GEOGRAPHICAL DISTRIBUTION

Distribution of the Genus in the World

The genus *Pedicularis* is confined to the northern hemisphere although *P. zeylanica* L. of Ceylon, and *P. incurva* Benth., of the Colombian and Ecuadorian Andes reach the equator. This is a genus belonging primarily to the arctic-alpine flora and which inhabits especially the arctic regions and alpine meadows in temperate regions. Only a few species, like *P. palustris* L. and *P. sylvatica* L. of Europe and *P. canadensis* L. and *P. lanceolata* Michx. of North America, are found in temperate lowlands. But such species are few, and they are closely associated with the larger flora in adjacent alpine or montane regions. Most species occur at altitudes of 800 meters and over, and some extend to the highest zone of plant life, where they may form the dominant element of the alpine meadows. Only a few species occur in the southern extensions of the genus, in Mexico, Central America, and the northern Andes and in Annam and Ceylon.

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[8] See pp. 205-216 of vol. 3, 1909, of the English translation by J. R. Davis of Paul Knuth's Handbook of Flower Pollination.

Detailed discussion of the geographical distribution of the genus was first made by Prain (75). He analyzed carefully all species of the world and divided them into eight provinces as follows: circumpolar, European, Sibero-Turkestan, Japanese, American, Caucasian, Chinese, and Himalayan. He found the largest number of species in the Himalayan province. Prain suggested that the genus originated in the circumpolar region and extended along meridian lines to these various areas. Bonati (19) gave a summary of the geographical distribution of the genus, largely accepting Prain's idea about the provincial divisions and the center of origin. Limpricht (58) traced the history of the genus and gave a detailed discussion on distribution according to the series as outlined by him. He suggested that the genus originated in the Altai-Tienshan Range. From there some species migrated eastward along the Sayan and other Siberian ranges, crossing the Pacific to Alaska, thence to arctic America, Greenland, Spitsbergen and northern Scandinavia; other species moved westward in another route through the Tienshan to Pamir and the Iran-Armenia chain, then to the Caucasus and the Pontic highlands and also the Alps.

Prain's provinces can be conveniently used to outline the general distribution of the genus. At his time, in 1898, the knowledge of the provinces, with the exceptions of the Chinese and the Himalayan ones, was fairly complete. Bonati added knowledge of these two provinces in 1918. Since then our information concerning them has been much further extended. A more detailed discussion on these two provinces of Prain will follow, but first a brief outline will be given for all the eight provinces. This will use Bonati's later, and more complete data, and for China will be supplemented by my own studies.

(1). The circumpolar province is " bounded by the Northern Summer Isothermal of 15° C." Of the 22 species listed by Bonati, 11 are endemic, this percentage of endemism being the lowest among the provinces. In the non-endemic species, there are those like *P. amoena* Adams, *P. oederi, P. resupinata, P. sudetica*, and *P. verticillata,* which are among the most widespread species of the genus. Some of the species have verticillate, others alternate leaves. Most of them have toothless corollas, some have toothed or beaked corollas, but none have long-tubular ones. Prain and Bonati believed that the genus originated in this province.

(2). The European province comprises the various mountain ranges of Europe such as the Pyrenees, Alps, and Carpathians. It extends northward to the lowlands of Scandinavia, eastward to the Volga and southward to the Mediterranean. Bonati listed for this province 47 species, 37 of which are endemic. With the exception of *P. amoena* and *P. verticillata,* two widespread species, all these are alternate-leaved. Among the corolla forms, the toothless, the toothed, and the beaked types are about equally numerous, with no representative of the long-tubular form. This province shares many species with the Sibero-Turkestan and the circumpolar provinces.

(3). The Sibero-Turkestan province comprises the mountain system lying northeast of the great Central Asian desert and regions nearby. It includes such ranges as the Tienshan, Alatau, Altai, Sayan, Baikal, and Jabloni, and also areas covering Turkestan, Siberia, Dzungaria, northern Mongolia, Manchuria, and Sakhalin Island. In the south it is limited by the Gobi desert. Bonati listed 63 species for the province, 42 of them endemic.[9] Both alternate- and verticillate-leaved species are present. All forms of corollas are found, with the toothed form greatly predominating. This province contains species in common with all other provinces. Limpricht is of the opinion that the genus originated in this province particularly along the Tienshan-Alatau range.

(4). The Japanese province is formed by Japan proper with the exclusion of Sakhalin in the north. Bonati listed 12 species, 10 of these being endemic.[9] The two non-endemics are the widely distributed *P. amoena* and *P. resupinata.* Four of the species are verticillate-leaved. All forms of corolla are represented with the toothless type predominating.

(5). The American province comprises North America exclusive of the arctic regions, south to Mexico, and with a small isolated district in the northern Andes of South America. In the north it passes on to the circumpolar province. Bonati listed 39 species[10] with 36 of them endemic. The species are all alternate-leaved, mostly with beaked corolla but toothless and toothed corollas are also well represented. Long-tubular ones are not present. Phylogenetically many of the species exhibit close kinship with Old World species.

(6). The Caucasian province includes the Caucasus, Armenia, Asia Minor, and Persia. In the north and west it is connected with the European province, in the northwest with the Sibero-Turkestan, and in the extreme east with the Himalayan. Bonati listed 18 species for the province, 14 of which are endemic. The species are almost equally divided between verticillate- and alternate-leaved species and all four types of corollas are present. The province has closer relationship with regions to the east, as shown by the number of species in common, than with the European and circumpolar provinces.

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[9] Including *P. refracta* Maxim., originally believed to be identical with Chinese plants from Kweichow, but now found to be distinct.

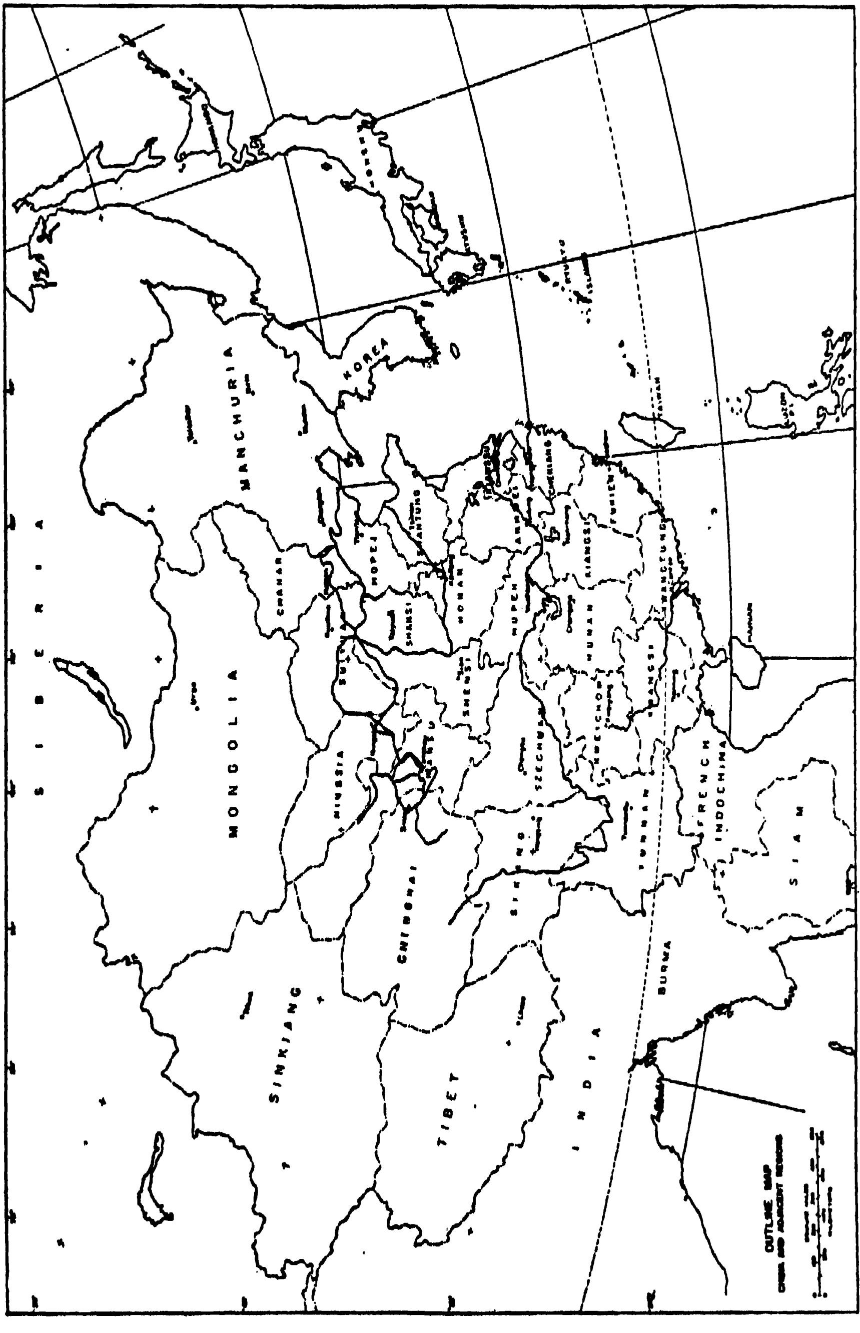
[10] A number of new species have since been described by Pennell, especially in the northwestern United States.

(7). The Chinese province of Prain is "indicated by the Kuen-lun, Nan-shan, and Peiling ranges. It extends northwards to the desert of Gobi, which separates it from the Siberian region, and southwards through the intervening tableland of Tibet to the Indus, the Sanpo, and the Yang-tze-kiang rivers, passing, however, insensibly into the Himalayan province." Prain had known only 49 species of this region in 1898. Bonati called this "Province Tibeto-Chinoise," and listed 125 species in 1918, 98 of these being endemic. Both alternate- and verticillate-leaved species are found, the later slightly predominating. All four forms of corollas are present, with long-tubular species being less than one-half, beaked and toothless species each slightly less than one-fourth, and toothed species less than one-twelfth the total. The province has many species in common with the Himalayan in the south and the Sibero-Turkestan in the north, but its relationship with other regions is exceedingly slight.

(8). The Himalayan province "is indicated by the Hindu-Kush, Karakoram, Himalaya, Yunnan, and Nan-ling (southern Nan-shan) ranges, including also the isolated mountain system of the Western Peninsula and the various parallel ranges of the Eastern Peninsula that pass northwards into Yunnan." At the time of Prain, only 101 species were known. Bonati called this "Province Himalayo-Yunnanaise" and listed 130 species, 106 of which are endemic. The non-endemic species are mostly in common with the Chinese province in the north. Both alternate- and verticillate-leaved species are found, the former being slightly more numerous. All four forms of corolla are found with the long-tubular species less than one-half, the beaked about one-third, and the toothless about one-fifth of the total. The toothed-corolla species amount to only one-thirteenth of the total. This province has by far the largest number of species, and many of them have the most highly evolved flowers. It is evident that its present conditions must be the most favorable for the development of the genus.

Of the regions pertaining to the Chinese areas, a more detailed analysis will be presented below. While the number of species in other regions has been only slightly increased since the time of Prain, those belonging to the two last provinces of Prain have been much augmented.

Among all the provinces of Prain, the circumpolar is the least well defined. It may be well divided and united with the adjacent regions. Also, Prain's idea about the circumpolar origin of the genus is not convincing. The number of species present in this province is small, and these do not show any substantial archaic morphological characterization. Limpricht's suggestion that the genus originated in the Altai-Tienshan Range is more acceptable. The Sibero-Turkestan region is located in almost the



Map 1.—Outline map of China and adjacent regions.

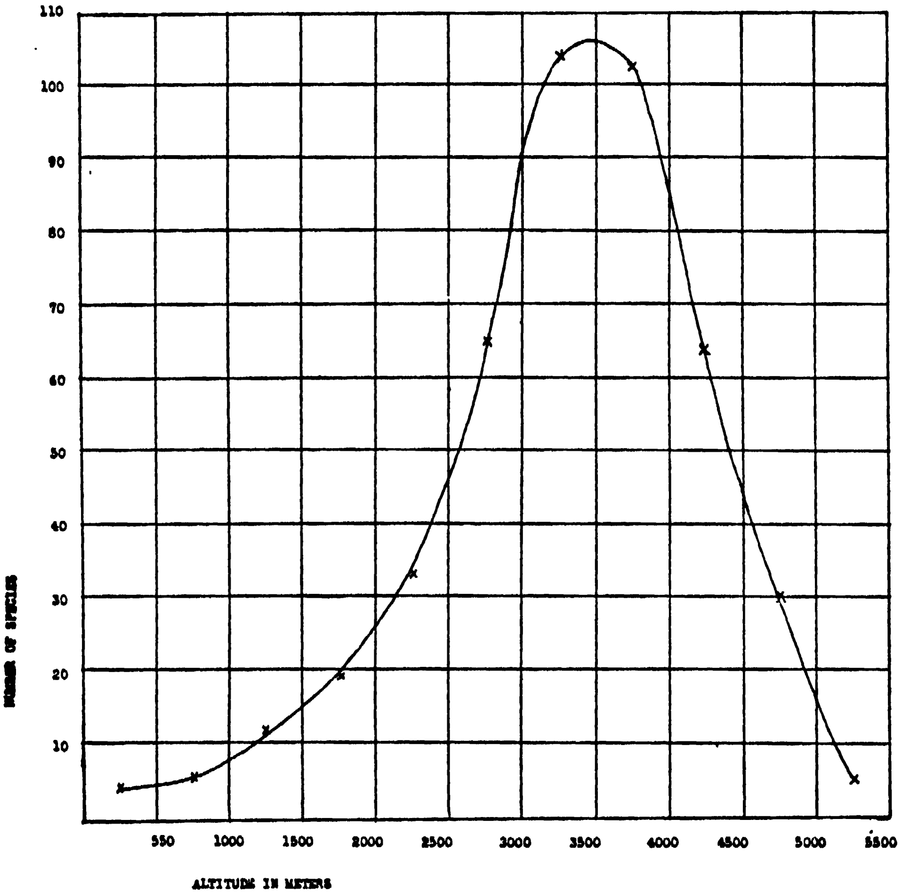
center of the present range of the genus *Pedicularis*. The species present in this region contain all forms of corollas but with the most archaic, the toothed-corolla species, predominating. Both alternate- and verticillate-leaved species are present. It is thus reasonable to suggest that the center of origin of the genus lies in the " Sibero-Turkestan province " of Prain, most especially along the Altai-Tienshan Range.

From this supposed center of origin, three main routes of migration are possible. One is directed eastward, to Manchuria and eastern Siberia, and thence either southeastward to Japan, or northeastward to the polar region, or eastward across the sea to Alaska and North America. The second route is westward to the Caucasus and Europe. A third route is southward to the mountain ranges of China, Tibet and the Himalayas. Along each of these routes, the species have found places of favorable abode and have occupied areas which became centers of secondary development. But the last route ends in the most suitable area for the existence of the genus. The recently elevated rugged mountain ranges, with their cool alpine meadows with abundant moisture, and also a rich insect fauna, have facilitated the highest development of this versatile genus.

Distribution of the Genus in China

Introduction.—For a study of the geography of the genus in China, maps showing the distribution of the various series and species have been prepared. These are made by plotting all the occurrences as far as their localities can be determined from labels and literature. On account of the lack of standardization in romanizing Chinese place names, some undetermined and doubtful ones have to be left out and some are only placed in approximate positions. Each map is used to show the area occupied by a single series, or in case of smaller series, several series of close relations. The distribution of the various species comprising the series are indicated by different types of signs.

Map 1 shows the provincial boundaries and names. It is presented to facilitate locating places quoted in the citation of specimens after each species, and to determine the area covered by the various distributional maps following, since, in most cases, these show only a portion of the country. This map is reproduced from one prepared by Mr. F. I. Burnham for use by members of the U. S. Department of Agriculture. The boundary between Sikang and Szechuan is modified in accord with the latest status, and the spelling of a few provincial names is changed to conform with the ones used in this treatise. Besides this map, all other maps are made on Goode's Series of Base Maps No. 226, prepared by Henry M. Leppard and published by the University of Chicago Press.



Graph 1.—Graph showing the altitudinal distribution of Chinese species of *Pedicularis.*

Altitudinal distribution.—*Pedicularis* occurs mostly at high altitudes; on the plains the species are rare. The dominant factor determining the distribution of the genus is temperature as affected by altitude, with moisture probably next in importance. The species are most abundant on the moist alpine meadows of northwestern Yunnan and Sikang. Farther north, in Chinghai, Kansu, Sinkiang and Mongolia, species are abundant also at high altitudes, especially along river banks and in moist places.

Of the 282 species now treated, the altitudes of about 220 are known from collectors' notes. These species, with their approximate ranges of altitudinal occurrence, are tabulated on the accompanying chart. Many species have a range of 500 or more meters, and are therefore counted more than once in the graph (Graph 1).

The majority of the species, as can be plainly seen from the diagram, are found at altitudes of about 2500 to 4500 meters, particularly between 3000 and 4000 meters. The meadows of these altitudes in the mountains of northwestern Yunnan, as well as in adjacent parts of Sikang and Burma, offer the most favorable habitat for the genus. Field records show that most of the species for which we lack definite records of altitude occur in alpine meadows.

The four species that grow below 500 meters are *Pedicularis henryi*, *P. sceptrum-carolinum*, *P. tsiangii*, and *P. resupinata*. *P. henryi*, occurring at altitudes of about 400 to 1420 meters, is the most widespread species in southern China, extending into Kiangsu, Kiangsi, Kwangtung, Kwangsi, and Hunan, where no other members of this genus are known. *P. sceptrum-carolinum* is a " wide " species extending from Europe to northern Asia, the var. *pubescens* being found in northern Manchuria, eastern Siberia, and Korea at altitudes of 400 to 500 meters. *P. resupinata* is also a widely distributed species occurring from Siberia through northern China to Korea and Japan. It is very widespread in China, being found in Anhwei, Shantung, Hopei, Chahar, Shansi, Szechuan, Manchuria, and Mongolia at altitudes of 300 to 1600 meters. *P. tsiangii*, occurring at an altitude of about 466 meters, is found only in southwestern Kweichow.

Among the species that exist at the highest altitudes, above 5000 meters, are *P. angustiflora* and *P. muscoides*, low and dwarf plants found on Mount Konka of Sikang Province, at altitudes of about 3960 to 5335 meters, and *P. pilostachya*, a densely hairy species found in Kansu and Chinghai at altitudes of 4720 to 5070 meters. *P. longiflora tubiformis* and *P. lachnoglossa*, two more or less widely distributed species, occur at a height from 2700 to 3500 meters respectively to an altitude of about 5300 meters, the latter occurrences being found in northwestern Yunnan.

General distribution of the species.—Map 2 shows the species population of the genus in eastern Asia. Each dot represents the presence of a single species in a certain area including adjacent phytogeographically related regions. The data are derived from herbarium records for the Chinese species and from statements of known ranges for extra-Chinese species.

A glance at the map will show the uneven distribution of the species over the area. Admitting the fact that some of the gaps may be due to certain places, such as central Nepal, Bhutan, etc., being inaccessible to collectors rather than to actual absence of species, the map gives a fairly exact picture of the proportional distribution of the species. If a map showing the mountain ranges of Asia be consulted, it becomes evident that the genus inhabits only the higher mountain areas. Its species are totally absent on the plains and hills along the coast of eastern and southern China, while only a few species occur on mountains a little inland. In the interior of Asia, in northern Tibet and on the deserts of Sinkiang and Mongolia, though the altitudes are high, lack of sufficient moisture accounts for the absence of species of this genus.

The greatest concentration of species is found along the Himalayan range and the mountains east to it in western China. In Kashmir, western Tibet, and the states along the Himalayas, many species occur through this great mountain system. However, more species are known from Sikkim, Chumbi, and adjacent parts of Nepal and Bhutan than from any other part of the range. Very few are known from central Nepal and eastern Bhutan, due to these territories being inaccessible to collectors rather than to their actual absence. With more thorough exploration, it is probable the species of *Pedicularis* will be found to be nearly evenly distributed along the range.

South of the Himalayas, the species are relatively few. A number occur in Assam, especially in the Khasia mountains, and most of these are endemic. North of the Himalayas, on the Tibetan Plateau, few species occur. This is due to the extreme desiccation as well as severe temperature. Geographically, the Himalayan range, running east to west and slightly convexing towards the south, ends at the easternmost curve of the Brahmaputra and Tsanpo Rivers. To the east, the Chinese mountains of Sikang and Yunnan, (and also of Burma), run almost north and south. This system of mountains is broader than the Himalayas and is also lower. These mountains are highest at the point opposite the Himalaya and gradually diminish toward the north and the south as well as toward the east. In the central region their height is comparable to that of the Himalayas. Four mighty rivers, the Yangtze, the Mekong, the Salween, and the Irrawady, run almost parallel with each other for a certain distance cutting deeply into the rugged chain. Near the northwestern tip of Yunnan these rivers flow within eighty miles of each other. It is in this region, northwestern Yunnan and adjacent parts of Sikang and upper Burma, that the greatest number of species of *Pedicularis* are found.

Over three-fourths of the Chinese species occur in this region. Most of them are endemic, although a number of widely distributed species are also found. Many of the highly specialized forms, those with long-tubular and long-beaked corollas, are present here. It seems that there is a gap between the species of this region and those of the Himalayas proper in the west, not only in the scarcity of species in intervening areas but also in the relation between the species of both regions. There are relatively few species common to both areas. Either related but specifically distinct species are found in both areas, or, if the same species is present, separate varieties occur. Geographically and phytogeographically, the two areas, though proximate, are distinct.

As the Chinese mountain system extends southward and gradually decreases, it forms the main axis of the Malay Peninsula. The number of species of *Pedicularis* drops abruptly beyond Tali around 26° N. Only a few occur to the southeast on the Yunnan Plateau and these scarcely extend beyond the Tropic of Cancer. Toward the east the mountain system passes very gradually to lower levels into the general relief of central and eastern China. A number of species are found in eastern Yunnan, Kweichow, Szechuan, and western Hupeh, but these are much fewer than occur in the western area of concentration.

To the north this mountain system passes imperceptibly into the Tibetan Plateau, where it comes into contact in northern Szechuan, eastern Chinghai, and Kansu, with the eastern extension of the Kwunlun system. Here we find a minor center of concentration of species, most of which are distinct from those found in the south. Some of these species and their near relatives occur along the Tsinling Range in Shensi, to Shansi, northern Hopei, and Chahar, approximately along the area traversed by the Great Wall.

North of the Great Wall is the Gobi Desert. A vast area in Mongolia and Sinkiang lacks any species of *Pedicularis*. However, before the area became desiccated, we may presume that vegetation was abundant and species of genera such as *Pedicularis* had ranges over this territory and that to the north and south of it. North of the desert area are a number of mountain chains extending east and west along the Chinese-Russian border. These include the Tienshan, the Alatau, the Altai, the Kangai, the Sajan, the Kentei, etc. Along these mountain systems are scattered a number of species. It is notable that most of these show archaic forms of corolla. It is evident that in former times, when more moisture was available, the species were more numerous. Considering the preponderance of primitive species, the central position of this area in the whole range of the genus, and the relative antiquity of the area geologically, it is presumed that these mountain systems show the place of origin for the genus.

Distribution of " wide " species.—In discussing the distribution of " wide " species, we may divide them into four groups: (1) Eurasian species—those of wide distribution in both Europe and Asia; (2) northern Asiatic species—those widely distributed in northern Asia; (3) eastern Himalayan species—those distributed along the eastern Himalayas and in China; and (4) Chinese species—those of wide distribution in China only.

(1) Eurasian species

A few species of wide distribution in Europe and northern Asia extend to northern Mongolia. These include *P. labradorica*, *P. palustris* (map 17), *P. comosa*, *P. laeta* (map 16), and *P. oederi typica* (map 28). *P. labradorica* and *P. oederi* are also found in northern North America. Of the varieties of *P. oederi*, *heteroglossa* is widely distributed from the central Himalayas to western and northern China, and *multipinna* and *rubra* are localized in Sikang and Sinkiang, respectively. *P. resupinata* (map 22) extends from Mongolia, Manchuria, and the northern Chinese provinces of Chahar, Shansi, Hopei, and Shantung to as far south as Anhwei. Varieties of the same species occur in western China in Shensi, Hupeh, Szechuan, Kweichow, and Kwangsi. *P. sceptrum-carolinum typica* (map 23) ranges from Europe to Siberia and northern Mongolia, while var. *pubescens* occurs in the east, in Manchuria, eastern Siberia, and Korea.

(2) Northern Asiatic species

A number of species are more or less widespread in northern Asia, extending their range into Sinkiang and northern Mongolia. They are *P. abrotanifolia*, *P. dolichorrhiza*, *P. lasiostachys*, *P. myriophylla*, *P. spicata*, *P. striata*, *P. tristis*, *P. uliginosa*, *P. venusta*, and *P. verticillata*. Among these species, some, like *P. dolichorrhiza* (map 16), extend to the Pamirs or western Himalaya; *P. striata* (map 15), *P. verticillata*, and *P. spicata* (map 9) are widespread in northern China; and *P. tristis* (map 24) occurs from Mongolia to Shansi.

These species, as well as the above Eurasian ones, appear to have the Tienshan-Altai range as their center of distribution; as already stated, they have invariably the more archaic forms of the corolla, and also they do not extend to the Sikang-Yunnan region where occur the largest number of species of *Pedicularis*.

Besides the species named above, the typical form of *P. longiflora* (map 44), a long-tubular species, is widespread from southern Siberia to northern China, but its var. *tubiformis* extends throughout the Himalayas to northwestern Yunnan and Sikang. *P. rhinanthoides* (map 34), another long-tubular species, has the typical form occurring from the western Himalayas northward to Dzungaria and Turkestan; while its var. *labellata* is widespread from the western Himalayas through Yunnan and Sikang to northern China. These more specialized species, judging from their different range of distribution, evidently have a different history from the other species mentioned above.

(3) Eastern Himalayan species

Although the eastern Himalayas closely approach northwestern Yunnan and Sikang, where the greatest concentration of *Pedicularis* species occurs, very few species of the genus are common to both these areas. These few are *P. elwesii* (map 37), *P. lachnoglossa* (map 26), *P. rex* (map 11), and *P. roylei* (map 9). *P. pantlingii*, an eastern Himalayan species, has a variety reported to occur in northern Burma and Yunnan, and *P. bella* another in Sikang.

Some of the species that are found in the eastern Himalayas are replaced by a variety of the same species or a closely related but different species in the adjacent Chinese area. Thus *P. gracilis* of the eastern Himalayas is replaced by var. *sinensis* (map 5). *P. integrifolia* of the Indian and Tibetan area is represented by the closely related but distinct *P. integerrima* (map 12). These differentiations, as well as the conspicuously small number of species in common, serve to show that the flora of the eastern Himalayas and that of Yunnan-Sikang, though closely associated, are distinct, and that their continuity has been broken in recent geological history. The region in middle Sikang, east of the Tsanpo River, probably delimits the two floras.

(4) Chinese species

Widely distributed species that are confined to the Chinese boundaries are very few. They either occur in the central and the south like *P. henryi* (map 18), or in the north like *P. chinensis* (map 44) and *P. artselaeri* (map 40).

Distribution of endemic species.—The majority of the species are endemic. These endemic forms can be grouped according to geographical regions. From north to south (except for the first), these regions are: (1) Western Sikang and Tibet; (2) Sinkiang and Mongolia; (3) Manchuria; (4) Chinghai, Kansu and Shensi; (5) Shansi, Hopei and Chahar; (6) Szechuan and Hupeh; (7) eastern Yunnan and Kweichow; (8) northwestern Yunnan and eastern Sikang. In a previous study of the phytogeographic regions of China,[11] the writer has divided the whole area into 14 regions, using the family Araliaceae as illustration. The groupings of the *Pedicularis* in the geographical sense fall in general within the scheme devised. A comparison of the two is now given. The original regions are arranged from south to north, since the Araliaceae is essentially a southern group.

Araliaceae	*Pedicularis*
1. Southern China maritime region	
2. Tonkin Gulf region	
3. Mid-Mekong region	
4. Sino-Himalayan region	**8. Northwestern Yunnan, eastern Sikang**
5. Southwestern China plateau region	**7. Eastern Yunnan, Kweichow**
6. Upper Yangtze region	**6. Szechuan, Hupeh**
7. Middle lake region	

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[11] Hui-Lin Li. The phytogeographic divisions of China, with special reference to the Araliaceae. Proc. Acad. Nat. Sci. Phila., 96, 249-277. 1944.

Araliaceae	*Pedicularis*
8. Eastern China maritime region	
9. Northern China plain region	4. Shensi, Hopei, Chahar
10. Northern China loess-highland region	5. Chinghai, Kansu, Shensi
11. Northeastern Chinese-Korean region	3. Manchuria
12. Mongolia desert-grassland region 13. Sinkiang basin region	2. Sinkiang, Mongolia
14. Tibetan plateau region	1. Western Sikang, Tibet.

No *Pedicularis* is known from the Tonkin Gulf Region. In the Southern China Maritime Region, only the widespread *P. henryi* (map 18) is known. In the Eastern China Maritime Region and the Middle Lake Region, besides *P. henryi*, *P. resupinata* (map 22) is also reported. The Mid-Mekong Region, although close to the greatest concentration of species in the north, has only a few species, like *P. rigida* (map 8) and *P. salviaeflora* (map 12), extending from its northern range into this region. Only one endemic species, *P. lunglingensis* (map 21), is found in the northern part of this region close to the adjacent region in the north. For the other regions, an account of their endemic species is given below.

(1) *Western Sikang and Tibet.*—Western Sikang, beyond the Tsanpo, is the eastern terminus of the Himalayas proper. The flora of this region is not yet fully known, but it shows more species in common with the eastern Himalayas than with northwestern Yunnan and eastern Sikang to the east. The following endemic species have been reported by recent exploration: *P. aschistorrhyncha* (map 37), *P. cryptantha* (map 28), and *P. mycophila* (map 30). The flora of Tibet proper is very poor. The southern part, like the Chumbi valley on the southern slope of the Himalayas, although politically part of Tibet, is geographically distinct. It has a rich flora which is actually part of the eastern Himalayan flora. The scanty flora of the north and the west is more related to the western Himalayas.

(2) *Sinkiang and Mongolia.*—Northern Sinkiang and northern Mongolia, north of the great desert area, are allied with adjacent parts of Siberia, floristically and geographically. The species present in this area have been listed among the " wide " northern Asiatic species. Some of them, though extending throughout Siberia, Mongolia, and Sinkiang, can be considered as essentially endemic to this general region, when it is, though of immense area, considered as a floristic province. A few more restricted and locally endemic species are: *P. fetissowi* (map 7), *P. hulteniana* (map 9), *P. moschata* (map 3), and *P. violascens* (map 9). The wide occurrence of most of the species in the area, and the relatively few endemics, as well as

the archaic nature of the corolla-structure of the species all point to the relatively ancient and prolonged history of the genus in this area. It is evident that speciation is not active now in the present environment.

(3) *Manchuria.*—Manchuria, together with eastern Siberia and northern Korea, forms a natural floristic region. Its flora is related to that of Mongolia and Siberia in the west, but is sufficiently distinct. As noted above, *P. sceptrum-carolinum*, widespread in the colder regions in Eurasia, becomes var. *pubescens* (map 23) in this area. In addition, *P. mandschurica* (map 16) and *P. grandiflora* (map 23) are endemic.

(4) *Shansi, Hopei, and Chahar.*—In the plain of northern China, *Pedicularis* does not occur. Only in the northern part of this region, in the mountains lining the plains, are a few species of *Pedicularis* found. The only endemics are *P. tatarinowi* and *P. provoti* (map 6).

(5) *Chinghai, Kansu, and Shensi.*—At the eastern extensions of the mighty Kwunlun range, in eastern Chinghai and Kansu, as well as Shensi and adjacent parts of Ningsia, northern Szechuan, and northern Sikang, is a rather important center of specific segregation in this genus. No less than 40 species, approximately one-seventh of the total number in China, are endemic to this area. These are:

P. alaschanica, P. anas, P. armata, P. bicolor, P. bidentata, P. bonatiana, P. calosantha, P. cheilanthifolia isochila, P. chenocephala, P. chingii, P. cranolopha, P. craspedotricha, P. cristatella, P. curvituba, P. davidi, P. decora, P. decorissima, P. dissecta, P. ingens, P. kansuensis, P. lasiophrys, P. merrilliana, P. moupinensis, P. odontochila, P. paiana, P. pilostachya, P. plicata, P. potanini, P. pygmaea, P. recurva, P. roborowskii, P. rudis, P. scolopax, P. semitorta, P. sima, P. szetschuanica typica, P. s. ovatifolia, P. tangutica, P. ternata, P. torta, and *P. xanthantha.*

(6) *Szechuan, western Hupeh.*—The flora of Szechuan province (except the very northern part) and western Hupeh is coherent and distinct. As the location of this region is rather central, it is but natural that it shares a number of " wide " species with adjacent regions. However, the numerous endemic species in the Yunnan-Sikang region to the west scarcely extend to this area. The number of endemic species known to this region only is also considerable. Notable is the predominence of the species of the series Longipedes (map 41) and the related Section Pteridoides (map 39). The endemic species are as follows:

P. conifera, P. fargesii, P. filicifolia, P. franchetiana, P. holocalyx, P. lasiantha, P. laxiflora, P. legendrei, P. longipes, P. nasturtiifolia, P. omiiana, P. phaceliaefolia, P. pteridifolia, and *P. vagans.*

(7) *Eastern Yunnan, Kweichow.*—Eastern Yunnan has a number of species in common with western Yunnan, but these are few compared with those common to western Yunnan and Sikang. Instead, eastern Yunnan, Kweichow, and part of southeastern Sikang, form a distinct natural region. Species endemic to this region only are:

P. aquilina, P. deltoidea, P. gagnepainiana, P. ganpinensis, P. kouytchensis, P. labordei, P. lutescens, P. nigra, P. stewardii, P. tachanensis, P. tahaiensis, P. tenuisecta, and *P. tsiangii.*

(8) *Northwestern Yunnan, eastern Sikang.*—The northwestern part of Yunnan and eastern part of Sikang, together with the adjacent part of Upper Burma, form a well defined floristic region especially known for its exceedingly numerous species of alpine-montane plants. These are confined to a congested area with the southern limit at 25° N. The only endemic species south of this limit is *P. lunlingensis.*

A total of about 160 species are endemic to this region. This is over one-half the total of all Chinese species. Many of the series, such as Pentagonae, Dichotomae, Salicifoliae, and Integrifoliae (all on map 12), Cernuae and Meteororhynchae (map 13), Debiles (map 14), Furfuraceae (map 19), Tsekouenses and Hirtellae (map 20), Trichoglossae and Lachnoglossae (map 26), Filiculae (map 30), Paucifoliatae and Macrorhynchae (map 31), Talienses and Subsurrectae (map 35), Macranthae (map 37), Corydaloides and Infirmae (map 40), occur in this region only. A list of the endemic species is given below. For the purpose of ready reference, they are grouped into three groups as follows:

(a) Species endemic within the Yunnan boundaries only:

P. acutiloba, P. aloensis, P. alopecuros, P. amplituba, P. angustilabris, P. aphyllocaulis, P. atuntsiensis, P. balfouriana, P. bambusetorum, P. brachycrania, P. cephalantha typica, P. crenata, P. crenularis, P. cyclorhyncha, P. debilis, P. dichrocephala, P. dissectifolia, P. dolichantha, P. dolichoglossa, P. dunniana, P. fastigiata, P. fengii, P. filicula, P. forrestiana, P. galeata, P. glabrescens, P. gracilicaulis, P. gruina, P. gyrorrhyncha, P. habachanensis, P. hirtella, P. humilis, P. infirma, P. insignis, P. kariensis, P. lamioides, P. laxispica, P. lecomtei, P. lineata, P. longicaulis, P. luteola, P. macilenta, P. macrorhyncha, P. mairei, P. maxonii, P. mayana, P. megalopha, P. micrantha, P. nudicaulis, P. obscura, P. oligantha, P. orthocoryne, P. pinetorum, P. polyphylloides, P. pseudocephalantha, P. pseudoingens, P. pseudoversicolor, P. remotiloba, P. salicifolia, P. sigmoidea, P. stadlmanniana, P. strobilacea, P. taliensis, P. tantalorhyncha, P. tomentosa, P. trichomata, P. tsaii, P. tsangchanensis, P. umbelliformis, P. villosula, P. wangii, P. yui, and *P. yunnanensis.*

(b) Species endemic within the Sikang boundaries only:

P. angustiflora, P. batangensis, P. bietii, P. brevilabris, P. cephalantha szetchuanica, P. cinerascens, P. connata, P. croizatiana, P. cupuliformis, P. cyathophylloides, P. daucifolia, P. dolichostachya, P. duclouxii, P. flaccida, P. floribunda, P. hemsleyana, P. kialensis, P. latituba, P. leptosiphon, P. lingelsheimiana, P. lophotricha, P. membranacea, P. muliensis, P. muscoides, P. paxiana, P. pectinatiformis, P. petitmenginii, P. pheulpinii, P. polyodonta, P. porphyrantha, P. princeps, P. pseudomuscicola, P. pseudosteningeri, P. quadrata, P. ramosissima, P. rhynchodonta, P. souliei, P. stenantha, P. steningeri, P. stenocorys, P. stevensii, P. szetschuanica angustifolia, P. tenera, P. tenuituba, P. thamnophila, P. tibetica, P. tongoloensis, P. variegata, P. wardii, and *P. yargongensis.*

(c) Species endemic to both Yunnan and Sikang, and sometimes to Upper Burma also:

P. axillaris, P. comptoniaefolia, P. crenata, P. corydaloides, P. cyathophylla, P. delavayi, P. densispica, P. dichotoma, P. dolichocymba, P. dolichosiphon, P. garnieri, P. gracilis sinensis, P. gracilituba, P. integerrima, P. likiangensis, P. limprichtiana, P. lipskyana, P. longiflora tubiformis, P. longipetiolata, P. macrosiphon, P. melampyriflora, P. microchila, P. monbeigiana, P. mussoti, P. oxycarpa, P. pentagona, P. praeruptorum, P. pseudomelampyriflora, P. rhodotricha, P. rupicola, P. sikangensis, P. smithiana, P. superba, P. tatsiensis, P. tsarungensis, P. tsekouensis, P. verbenaefolia, and *P. vialii.*

GEOGRAPHICAL NAMES

In citing geographical place names, I have followed the original ones that appeared on the labels. No attempt has been made to standardize these. In practically all cases, Chinese characters are not given on these labels, and thus a different transliteration might result in error. Although the names appear variously in English, French, or German, the major ones, like that of a city or district, can often be easily ascertained by consulting maps of different languages or by tracing the routes undertaken by the collectors. Difficulties, however, are often encountered in locating minor places such as towns or villages. It is found that the practice of giving either the longitude and latitude, or the place name in Chinese, is of considerable help in locating them.

Among the maps in Chinese, the New Atlas of the Chinese Republic, by V. K. Ting, W. H. Wong, and S. Y. Tseng, published in Chinese by Shun Pao, Shanghai, in 1933, is the most accurate and up-to-date. The maps, however, pertaining to the regions of northwestern Yunnan, Sikang, southwestern Szechuan, etc., where the genus *Pedicularis* especially flourishes, are not in sufficient detail for the present purpose. In this case, some of the maps on western China included in the series "Maps of India and adjacent countries," published by the Survey of India Office, Calcutta, have proved the most useful. Other maps in Chinese, English, and French have also been consulted. Many of the sketch maps given by collectors such as Rock, Ward, Limpricht, and others, are indispensable in ascertaining the localities of many of their own and other workers' collections.

Considerable confusion exists in the citation of provincial boundaries as given by various collectors. Some of the earlier collectors assign to "Tibet" the provinces now known as Chinghai and Sikang, and even parts of Szechuan or northwestern Yunnan. Chinghai province is also known as Kokonor. Sikang, formerly a "Special District," is now made into a province comprising part of what was eastern Tibet and part of western Szechuan. Lately, several districts in southwestern Szechuan, including Hui-li, Si-chang, etc., that were originally in Szechuan, have been transferred by the National Government to Sikang. Provincial boundaries have also changed considerably in northern China in what was formerly known as Inner Mongolia. In order to bring political geography up-to-date, it is necessary that the boundaries be delineated according to the latest official records. In this study, changes have accordingly been made, whenever thought necessary, in the citation of specimens in the text. Ting-Wong-Tseng's Atlas is followed in all cases except for the recent change between Sikang and Szechuan (made subsequent to the publication of that Atlas). This change of the boundaries is shown in the 4th edition (1939) of the New Atlas of the Provinces of China (in Chinese), by the same authors and also published by Shun Pao of Shanghai, which is an abridged edition of the Atlas of the Chinese Republic.

NOMENCLATURE AND CITATION OF LITERATURE

An attempt is made to cite all important references to the names pertaining to all Chinese species of *Pedicularis*. However, the list under each name is nevertheless not complete, as such references in enumerations of local plants as do not have direct bearing on the taxonomy or distribution of the genus are usually not given. Considerable effort has been made to ascertain the validity of the identifications made by different authors, and these, as verified, are noted as such. It is the necessary and obliging duty of a reviewer of a given group to clarify as much as possible confusions in nomenclature and synonymy, so that a subsequent worker on the same group or one consulting the work for reference purposes need not repeat the same task.

The current practice of citing certain synonyms in botanical literature appears to be confusing. Many authors, especially monographers, have listed misidentified names in synonymy, and too often without making a clear-cut distinction between these and ordinary synonyms that are based on validly published entities. Some authors use the word " sensu " between the specific name and the author who made the identification, and list at the end of the citation the original author after the word "non." This avoids the misconception of a certain name being made by two different authors (homonym) as is too often the case with names in the Index Kewensis. However, as latin words are customarily italicized, these additional latin words given together with the name do not stand out sufficiently clearly for immediate recognition.

As a misidentified name is not of equal standing with an ordinary synonym, which is a validly published botanical entity, in this treatise these misidentified names are enclosed by quotation marks with a citation that tells which author made this identification as well as the original author of the name. Such misidentifications are usually given at the end of the list of synonyms for each species. For ordinary usage, these are not considered as synonyms and so need not necessarily be cited.

Herbaria Consulted

The herbarium of the late Gustave-Henri Bonati was acquired on behalf of the California Botanical Garden, and is now deposited with the University of California at Los Angeles. The collection is especially rich in the Scrophulariaceae, particularly in *Pedicularis,* for which Bonati had projected but not completed a world monograph. The plants of this family are on loan to the Academy of Natural Sciences of Philadelphia. There are many type and classical specimens as well as many unnamed collections. Most of the material is not otherwise represented in this country. However, Bonati consulted to a great extent the collections of the Paris Museum, and the types of some of his own species are there rather than in his own herbarium. From this institution, Bonati had some duplicates of Franchet's types. Bonati's herbarium also includes the collections made by Pére Maire and Pére Soulié, mostly from the northwestern part of Yunnan and the eastern part of Sikang respectively. Among these collections, the later ones are all unmounted and each consists of many specimens, evidently being collections that have never been distributed. They are either unnumbered or else numbered by Bonati. In addition to Soulié's and Maire's collections, Bonati's herbarium has extensive sets of material representing the collections of Bodinier, Cavalerie, Delavay, Ducloux, Esquirol, Farges, Giraldi, Handel-Mazzetti, Monbeig, Potanin, Przewalski, Wilson and others. These were mostly secured from European herbaria, especially from Kew, Edinburgh, Paris, Berlin, and St. Petersburg (now Leningrad).

Besides the herbarium of Bonati, other material seen for this study is mostly from American herbaria. Specimens of *Pedicularis* in the Old World have been received on loan from all leading herbaria in the country. The United States National Herbarium has the most complete sets of the very extensive and important collections of Rock. In his unnamed later collections, many novelties are being discovered. This institution also has some of the specimens of Handel-Mazzetti, Henry, Schneider, Schoch, Wilson, etc. The New York Botanical Garden collections contain many important older series such as those of Schrenk, Soulié, and some specimens of Henry, Wilson and others. It also has many specimens made by Chinese collectors around 1930 and earlier, some of which are also represented in the collections of the University of California. They include such collectors as Chiao, Ching, Feng, C. W. Wang, H. Wang, Tsai, Yü, etc. The Gray Herbarium collections contain the invaluable early Indian collections of Hooker and also some of the recent Chinese collections. In the herbarium of the Arnold Arboretum are found extensive sets of specimens made recently by such Chinese collectors like Ching, Feng, Wang, Tsai, Yü and others. Many novelties are being discovered in these collections. The herbarium of the Academy of Natural Sciences of Philadelphia has some of the early collections of Ledebour and Schrenk made in Turkestan and of Wallich in India. It also has sets of Rock's collections made in recent years.

The herbaria studied are represented by the following abbreviations after the specimens cited. Considerable amount of extra-Chinese material has been on loan from the Dehra herbarium of India to the Academy of Natural Sciences of Philadelphia. This has also been available for consultation and reference. Occasional citations of specimens from these herbaria are made as such.

Academy of Natural Sciences of Philadelphia (ANSP); Arnold Arboretum of Harvard University (AA); Bonati Herbarium (to be deposited at the University of California at Los Angeles with many duplicates at ANSP) (B);[12] Brooklyn Botanic Garden (BBG); Chicago Natural History Museum (formerly Field Museum of Natural History) (CM); Gray Herbarium of Harvard University (GH); Missouri Botanical Garden (MBG); New York Botanical Garden (NYBG); Royal Botanic Garden, Edinburgh (RBGE); University of California (UC); University of Pennsylvania (UP); and United States National Herbarium (USNH).

For footnote see bottom of next page.

SYSTEMATIC TREATMENT

PEDICULARIS Linnaeus

Pedicularis L., Sp. Pl., 607, 1753; Gen. Pl., ed. V, 266, 1754. Generic type, *P. sylvatica* L., Sweden; see Pennell in Proc. Acad. Nat. Sci. Phila., 82: 18, 1930.

Calyx ovoid, campanulate to tubular, cleft or not cleft anteriorly, 2-5-dentate, the teeth equal or more usually unequal, the laterals distinct or united, often dentate, the posterior one usually smaller and entire or sometimes absent. Corolla with a tube mostly about as long as, or slightly longer than, the calyx, though sometimes shorter or many times longer; distal part of the corolla 2-lipped; upper lip (galea) forming a compressed hood, usually erect proximally and bending distally, the apex either truncate or acute and entire, or 2-dentate, or prolonged into a short or long, straight or coiled beak; lower lip often spreading, 3-lobed, the lobes equal or unequal, the middle one often distad. Stamens 4, didynamous, the filaments glabrous or hairy, or usually the anterior pair hairy distally and the posterior glabrous, the anther-pairs usually approximate, the cells equal, distinct, parallel. Ovary ovoid or lanceolate, usually slightly oblique, 2-celled, the ovules many. Styles glabrous, the stigmas wholly united, subcapitate, included or exserted. Capsules usually compressed-ovoid to ovoid-lanceolate, often more or less oblique and rostrate, loculicidally dehiscent. Seeds numerous, variable in shape from ovoid to oblong, straight or curved, the testa variously reticulated, striated, or pitted.

Perennial herbs, rarely annual, usually semi-parasitic or rarely semi-saprophytic. Leaves radical or cauline, alternate, subopposite, opposite, or 3-5-, usually 4-verticillate, mostly pinnately lobed or divided, rarely dentate, or crenate, or even entire. Rhizomes often with membranaceous scales at the top. Flowers sessile to pedicellate, often centripetally arranged near the apex of the stem or branches, in long or short spikes or racemes, or sometimes scattered and axillary.

A genus of about 600 species in the northern hemisphere, especially in the arctic and subarctic, and the alpine-montane areas of the temperate regions. About 280 species are known from China.

Synopsis of the Chinese Series of Group I, Cyclophyllum

A summary of the classification of the genus in China as represented by the system devised in this study has been prepared. Divisions are presented down to series. The essential characters of each group are given, but under each series only the most outstanding characters, especially those that could be used to differentiate it from related series, are stated. Each series includes a key to its component species. The present portion deals only with Group I, and this synopsis is followed by an artificial key to its series.

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[12] Since Dr. Li's return to China, the specimens of the Bonati Herbarium have been divided between the two institutions as denoted below on the citations of specimens under each species. The Yunnan collections, mentioned above usually comprise further duplicates of which a set will go to Dr. Li in China and the remainder are to be distributed to various other herbaria. F. W. P.

GREX I. CYCLOPHYLLUM

Erectae; foliis verticillatis, interdum oppositis vel ternatis; inflorescentiis terminalibus, spicatis vel racemosis; floribus oppositis vel verticillatis, sessilibus vel breviter pedicellatis.

SECTIO I. ORTHOSIPHONIA. Folia verticillata, plerumque dissecta; corollae tubo in calyce recto.

Series 1. Abrotanifoliae. Elatae, simplices vel ramosae; foliis profunde pinnatifidis vel pinnatisectis, segmentis pinnatifidis vel serratis; corollae tubo in calyce recto, supra calycem curvato; galeā apice truncatā. (Species 1-6, figures 1-6.)

Series 2. Cheilanthifoliae. Elatae, strictae, pluricaules; foliis profunde pinnatifidis vel pinnatisectis, segmentis linearibus, dentatis; corollae tubo supra calycem recto vel valde leviter curvato; galeā apice valde breviter rostratā. (Species 7-10, figures 7-8.)

Series 3. Melampyriflorae. Elatae, rigidae, plerumque ramosae; foliis pinnatisectis, segmentis pinnatifidis; corollae tubo recto; galeā valde breviter rostratā, apice bidentatā. (Species 11-14, figures 9-12.)

Series 4. Longicaules. Elongatae, graciles, longe ramosae; foliis profunde pinnatifidis, lobis pinnatifidis; corollae tubo inferne recto, supra calycem leviter curvato; galeā distincte rostratā; labio inferiore 3-lobato, lobo medio acuminato. (Species 15-16, figures 13-14.)

Series 5. Coniferae. Strictae, elatae, breviter ramosae; foliis pinnatisectis, segmentis pinnatifidis, corollae tubo recto; galeā distincte rostratā; labio inferiore 3-lobato, lobo medio cucullato. (Species 17.)

Series 6. Graciles. Elongatae, rectae, graciles, paniculato-ramosae; foliis pinnatifidis, lobis serratis; corollae tubo recto; galeā longe rostratā; rostro galeam superante. (Species 18, figure 15.)

Series 7. Myriophyllae. Elatae, pluricaules; foliis pinnatisectis, segmentis pinnatifidis; corollae tubo recto; galeā gradatim rostratā; rostro conico. (Species 19-22, figures 16-18.)

Series 8. Simae. Elatae, simplices vel pluricaules; foliis pinnatifidis, segmentis serratis; corollae tubo recto; galeā abrupte rostratā; rostro brevi, obtuso. (Species 23.)

Series 9. Pectinatae. Elatae, pluricaules; foliis profunde pinnatifidis vel pinnatisectis; corollae tubo recto; galeā longe rostratā; rostro gracili, plus minusve recto. (Species 24-28, figures 19-20.)

Series 10. Semitortae. Elatae, plerumque pluricaules; foliis profunde pinnatifidis vel pinnatisectis, lobis pinnatifidis vel serratis; bracteis plerumque 3-5-fidis; corollae tubo recto; galeā longe rostratā; rostro gracili, valde curvato; labio inferiore glabro, lobo medio haud cucullato. (Species 29-32, figures 21-22.)

Series 11. Gyrorrhynchae. Elatae, strictae, simplices, ramosae; foliis profunde pinnatifidis vel pinnatisectis, lobis pinnatifidis; corollae tubo recto; galeā longe rostratā; rostro gracili, valde curvato; labio inferiore ciliato, lobo medio cucullato. (Species 33-36, figures 23-26.)

SECTIO II. RIGIOCAULUS. Robustae, rigidae; foliis verticillatis, simplicibus, serratis; corollae tubo in calyce recto.

Series 12. Rigidae. Elatae, plerumque ramosae; foliis breviter petiolatis, pinnatifidis, lobis serrulatis; corollae tubo recto; galeā valde breviter rostratā, bidentatā. (Species 37-39, figures 27-28.)

Series 13. Alopecuroides. Elatae, strictae, foliis sessilibus vel breviter petiolatis, oblongis vel lanceolatis, pinnatifidis, lobis serrulatis; galeā longe rostratā, edentatā; rostro gracili. (Species 40-42, figures 29-31.)

SECTIO III. SIGMANTHA. Folia verticillata, dissecta; corollae tubo in calyce conspicue curvato.

Series 14. Verticillatae. Strictae, simplices vel pluricaules, interdum ramosae; foliis pinnatifidis vel pinnatisectis; corollae tubo in calyce curvato; locellis antherarum basi acutis. (Species 43-68, figures 32-52.)

Series 15. Plicatae. Strictae, simplices vel pluricaules; foliis pinnatisectis, segmentis pinnatifidis vel pinnatisectis; corollae tubo in calyce curvato; galeā superne dilatatā, fronte rotundatā, apice truncatā, integrā; locellis antherarum basi longe acuminatis. (Species 69-70, figures 53-54.)

Series 16. Curvitubae. Strictae, simplices vel pluricaules; foliis pinnatisectis, segmentis pinnatifidis vel serratis, corollae tubo in calyce valde curvato; galeā breviter rostratā; rostro horizontali. (Species 71-73, figures 55-56.)

SECTIO IV. CYATHOPHORA. Folia verticillata; petiolis vel bracteis basi dilatatis, connatis.

Series 17. Cyathophylloides. Elatae, strictae; calyce campanulato, chartaceo, piloso, dentibus 5, plus minusve aequalibus, serratis; corollā superne puberulā; tubo brevi; galeā haud rostratā, edentatā vel valde obscure dentatā; labio inferiore lato, galeam superante; filamentis glabris. (Species 74, figure 57.)

Series 18. Reges. Elatae, strictae; calyce campanulato, tenuiter membranaceo, glabro, dentibus 2, rotundatis, integris; corollā superne dense pubescente, galeā haud rostratā, distincte bidentatā; labio inferiore angusto, galeam breviore; filamentis villosis. (Species 75-78, figures 58-61.)

Series 19. Superbae. Strictae; calyce campanulato, reticulato, dentibus 5, ovato-oblongis, serratis; corollae tubo brevi, calycem ad duplo longiore; galeā longe rostratā; filamentis villosis. (Species 79, figure 62.)

Series 20. Cyathophyllae. Strictae; calyce longe cylindrico, haud reticulato, dentibus 2, oblongo-lanceolatis, serratis; corollae tubo cylindrico, calycem 2-4-plo longiore; galeā longe rostratā; filamentis villosis. (Species 80-81, figures 63-64.)

SECTIO V. MACROCLADUS. Elatae; caulibus gracilibus, diffuse ramosis, ramis oppositis.

Series 21. Salviaeflorae. Calyx campanulatus, 5-dentatus; corollae tubo calycem duplo longiore; galeā longā, rectā, apice inconspicue vel haud bidentatā. (Species 82, figure 65.)

SECTIO VI. POLYSCHIZOPHYLLUM. Folia opposita, bipinnatisecta, segmentis linearibus; calyce inflato, subtiliter reticulato.

Series 22. Pentagonae. Strictae, simplices vel ramosae; galeā haud rostratā, bidentatā; labio inferiore fimbriato. (Species 83, figure 66.)

Series 23. Dichotomae. Strictae, simplices vel ramosae; galeā obscure bidentatā, apice longe rostratā; rostro gracili; labio inferiore integro. (Species 84, figure 67.)

SECTIO VII. HOLOPHYLLUM. Nanae; foliis oppositis, lanceolatis, subintegris.

Series 24. Salicifoliae. Humiles, simplices vel ramosae; foliis caulinis; calyce cylindrico, haud fisso, dentibus integris; galeā apice truncatā; filamentis ad basim et apicem villosis, medium versus glabris. (Species 85, figure 68.)

Series 25. Integrifoliae. Nanae, pluricaules, simplices; foliis radicalibus vel caulinis; calyce cylindrico-campanulato, fisso, dentibus crenulatis; corollae tubo calycem superante; galeā longe rostratā; rostro gracili, sigmoideo; filamentis omnino villosis. (Species 86, figure 69.)

SECTIO VIII. BRACHYPHYLLUM. Humiles vel elatae; foliis caulinis oppositis raro ternis, brevibus, latis, subsessilibus vel breviter petiolatis, raro longipetiolatis, simplicibus vel pinnatifidis, raro pinnatisectis.

Series 26. Lyratae. Humiles, raro elatae; galeā truncatā, apice bidentatā vel multi-dentatā. (Species 87-96, figures 70-77.)

Series 27. Debiles. Humiles; galeā integrā, raro bidentatā, apice longe rostratā; rostro gracili. (Species 97-104, figures 78-84.)

SECTIO IX. DOLICHOPHYLLUM. Elatae; foliis radicalibus vel caulinis, longe petiolatis, dissectis.

Series 28. Cernuae. Strictae; foliis profunde pinnatifidis, lobis pinnatifidis; corollae tubo recto; galeā inferne rectā, superne leviter curvatā, apice haud rostratā, bidentatā. (Species 105, figure 85.)

Series 29. Pseudorostratae. Folia pinnatisecta, segmentis pinnatifidis; corollae tubo recto; galeā apice breviter rostratā; rostro lato, galeam breviore. (Species 106-108, figures 86-87.)

Series 30. Meteororhynchae. Strictae; foliis profunde pinnatifidis vel fere pinnatisectis, segmentis pinnatifidis; corollae tubo superne valde curvato, torto; galeā longe rostratā; rostro gracili, subsigmoideo, galeam superante. (Species 109, figure 88.)

GREX II. ALLOPHYLLUM

Strictae; foliis alternis; inflorescentiis terminalibus, racemosis vel spicatis; floribus alternis, sessilibus vel breviter petiolatis, raro longe petiolatis. (Series 31-65, to be considered in Part II.)

GREX III. POECILOPHYLLUM

Humiles vel elatae; caulibus gracilibus, flexuosis vel scandentibus, raro rectis; foliis plerumque longe pedicellatis, raro subsessilibus vel breviter petiolatis, axillaribus, sparsis, raro densis. (Series 66-79, to be considered in Part II.)

Analytical Key to the Series of Pedicularis, Grex Cyclophyllum, in China

Analytical keys, based on obvious, but in many instances artificial characters, to the series as found in China, are herewith given. Often the characters used will apply only to Chinese species. Further keys to the species involved are to be found under the treatment of each series. The artificial keys can be used in conjunction with the synopses of the three groups into which the genus is now divided; these synopses, placed at the commencement of each group, present a more natural outline of the genus.

A. Leaves opposite or verticillate; flowers opposite or verticillate, usually in terminal racemes or spikes. [Group I. Cyclophyllum.]

B. Leaves opposite to 3- or 4-verticillate, the petioles of leaves and the bases of bracts distinct, not connate.

C. Corolla without a beak.

D. Galea with teeth on the lower margins near the apex.

E. Leaves opposite, rarely both opposite and ternate; galea truncate at apex, not protruding.

F. Leaves pinnatifid to subpalmately lobed, the lobes broad, not distant.

G. Radical leaves usually many, very large and long-petiolate. .... 28. *Cernuae*

GG. Radical leaves few or none, no larger than the cauline, usually short-petiolate. ..... 26. *Lyratae*

FF. Leaves bipinnatisect, the lobes linear, distant. 22. *Pentagonae*

EE. Leaves 3- or 4-verticillate; galea ending in a slightly protruding apex.

F. Leaves pinnatifid; calyx-teeth very small, short, entire. 12. *Rigidae*

FF. Leaves pinnatisect; calyx-teeth prominent, deltoid to elliptic, entire or serrate. .... 3. *Melampyriflorae*

DD. Galea without teeth on the lower margins near the apex.

E. Leaves opposite or subopposite.

F. Leaves strictly opposite, sessile, lanceolate, entire; flowers in terminal spikes. .... 24. *Salicifoliae*

FF. Leaves opposite, subopposite to alternate, petiolate, broad in outline, pinnatifid to pinnatisect; flowers axillary, scattered or rarely the upper ones racemose.

G. Plant robust; flowers very large, the lower corolla-lip as long as the galea. .... 21. *Salviaeflorae*

GG. Plant delicate; flowers much smaller, the lower corolla-lip much shorter than the galea. 66. *Aloënses* [Part II]

EE. Leaves 3- or 4-verticillate or rarely verticillate and opposite.

F. Corolla-tube more or less straight in the calyx.

G. Corolla-tube bending forward above the calyx at the junction of the tube and the galea; galea with apex truncate, not protruding. .. 1. *Abrotanifoliae*

GG. Corolla-tube straight above the calyx, not bending; galea ending in a broad, short, protruding apex. .... 2. *Cheilanthifoliae*

FF. Corolla-tube more or less strongly curved and inflexed in the calyx.

G. Corolla purple, pink, or red, with a relatively narrow galea; anther-cells acute at base. 14. *Verticillatae*

GG. Corolla yellow, with a relatively broad galea slightly enlarged distally; anther-cells long-acuminate at base. .... 15. *Plicatae*

CC. Corolla with a distinct beak.

D. Corolla with a short, relatively broad tube, 1 to 1½ (-2) times as long as the calyx; beak broad, shorter than the galea.

E. Low plants; leaves mostly radical, the cauline leaves opposite or rarely opposite and ternate. .... 29. *Pseudorostratae*

EE. Tall plants; leaves all or mostly cauline, 3-4-verticillate or rarely opposite and verticillate.

F. Stems branching at base only, not branching distally.

G. Corolla-tube straight, the galea straight proximally, bending near the tip.

H. Leaves pinnatisect; bracts and calyces ciliate; galea gradually narrowed into the beak. 7. *Myriophyllae*

HH. Leaves pinnatifid; bracts and calyces hirsute; galea abruptly narrowed into the beak. 8. *Simae*

GG. Corolla-tube infracted in the calyx and again curved and inflexed above the calyx at the junction of the tube and the galea. .. 16. *Curvitubae*

FF. Stems branching distally, the branches long or short, spreading or ascending.

G. Branches diffuse, long, slender; mid-anterior lobe of the lower corolla-lip acuminate. .. 4. *Longicaules*

GG. Branches short, ascending; mid-anterior lobe of the lower corolla-lip cucullate. ..... 5. *Coniferae*

DD. Corolla with a relatively slender tube, about 1½ to usually twice or more the length of the calyx; beak longer than the galea.

E. Leaves opposite to subopposite, rarely opposite and ternate.

F. Leaves broad in outline, pinnatifid to pinnatisect.

G. Flowers long-pedicillate, more or less scattered and axillary.

H. Pedicels two or more times as long as the calyx; corolla-tube 2-2½ times as long as the calyx, glabrous externally; galea without teeth. .... 73. *Longipedes* [Part II]

HH. Pedicels two times as long as the calyx or less; corolla-tube long, slender, 3 or more times as long as the calyx, hairy externally; galea with one tooth on each lower margin. 76. *Batangenses* [Part II]

GG. Flowers short-pedicillate, in terminal racemes.

H. Leaves mostly pinnatifid to sometimes once pinnatisect, the lobes broad, not distant; calyx not inflated nor reticulate.

I. Leaves mostly cauline; corolla-tube erect, not twisted; galea not twisted, the beak horizontal, more or less straight. 27. *Debiles*

II. Leaves mostly basal; corolla-tube strongly bending above the calyx, twisted; galea often twisted, the beak somewhat sigmoid, upraised. 30. *Meteororhynchae*

HH. Leaves bipinnatisect, the lobes linear, distinct; calyx inflated, finely reticulate. 23. *Dichotomae*

FF. Leaves narrow, lanceolate, entire to obscurely crenulate. 25. *Integrifoliae*

EE. Leaves 3-4-verticillate.

F. Stems many-branched above; flowers laxly arranged in racemes. .... 6. *Graciles*

FF. Stems unbranched or few- and short-branched above; flowers arranged in terminal spikes, compact or interrupted.

G. Beak more or less straight and horizontal; bracts ovate to oblong, not 3-5-fid.

H. Leaves pinnatifid, sessile to short-petiolate. 13. *Alopecuroides*

HH. Leaves pinnatisect, more or less distinctly petiolate. .... 9. *Pectinatae*

GG. Beak strongly bending or coiled; often forming a semi-circle.

H. Bracts usually 3-5-fid; lower corolla-lip with glabrous margins and non-cucullate middle lobe. .... 10. *Semitortae*

HH. Bracts not 3-5-fid; lower corolla-lip with ciliate margins and cucullate middle lobe. 11. *Gyrorrhynchae*

BB. Leaves 4-verticillate, the petioles and the bases of the bracts dilated and connate below.

C. Galea without a beak, the apex broad and truncate, with or without a tooth on each side of the lower margins.

D. Calyx membranaceous, glabrous, with 2 rounded entire lobes; galea with the apex pointing downward, with a distinct tooth on each side. .... 18. *Reges*

DD. Calyx chartaceous, pilose, with 5 ovate serrate teeth; galea with the apex pointing upward, without teeth or very obscurely dentate. .... 17. *Cyathophylloides*

CC. Galea ending in a long distinct beak, without teeth.

D. Calyx short, campanulate, with 5 ovate-oblong teeth; corolla-tube twice as long as the calyx. .... 19. *Superbae*

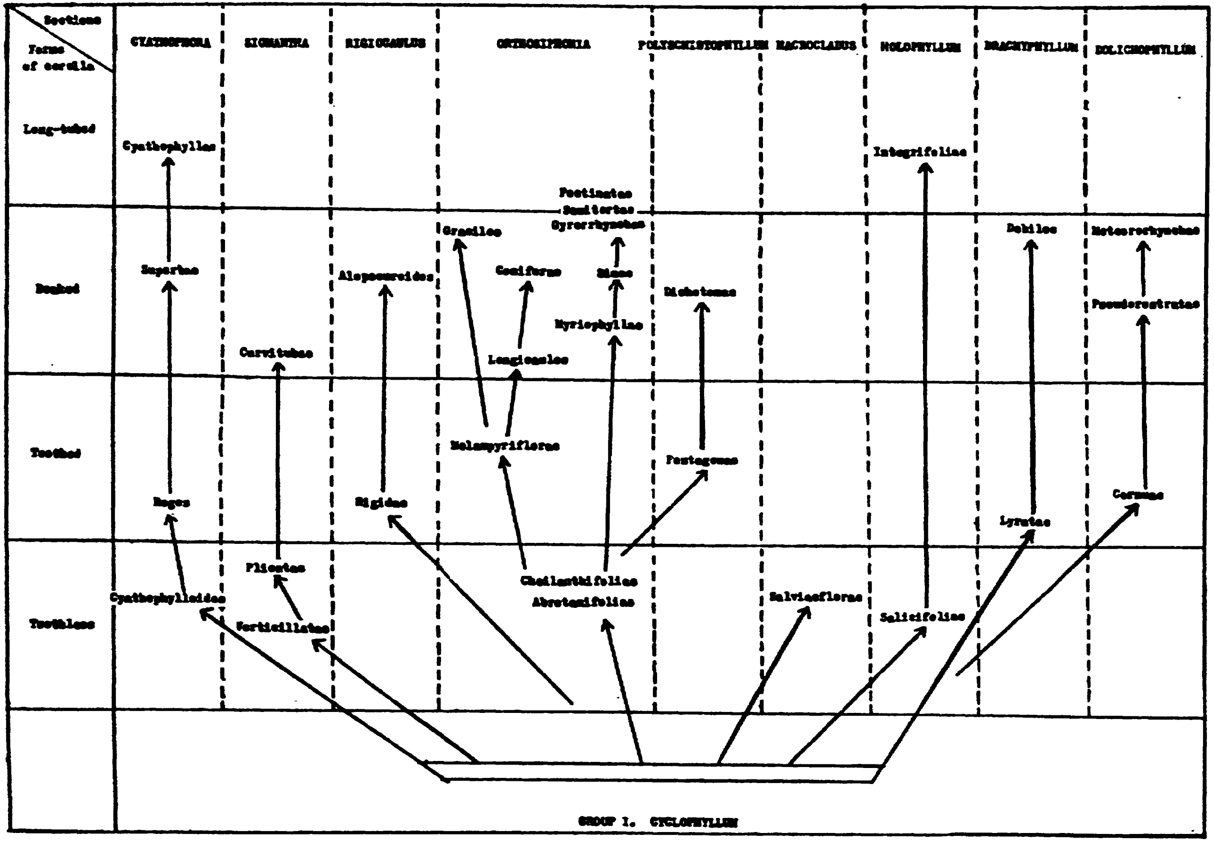
DD. Calyx long-cylindric, with 2 oblong-lanceolate teeth; corolla-tube long-cylindric, 2-4 times as long as the calyx. .... 20. *Cyathophyllae*

AA. Leaves alternate, or alternate and opposite or subopposite; flowers alternate, or sometimes some subopposite, in spikes or racemes, or axillary and scattered. [Groups II, Allophyllum, and III, Poecilophyllum, in Part II.]

GROUP I. CYCLOPHYLLUM

Erect, low or tall plants, the stems simple or branching; leaves 4-verticillate, sometimes opposite or ternate, sessile to petiolate, simple to pinnatisect; inflorescences terminal, spicate or racemose, the flowers opposite or verticillate, sessile to short-pedicellate; corolla with a tube about as long as, to twice as long as the calyx, rarely much longer, erect to curved, usually enlarged distally; galea with the apex either entire, toothed, or beaked.

The kinship of the different sections and series, as well as their degree of floral modification, are graphically shown on Diagram 1.



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SECTION I. ORTHOSIPHONIA

Erect, usually tall plants, the stems simple or branching; leaves usually 4-verticillate, deeply pinnatifid to pinnatisect, distinctly and long-petiolate; inflorescences spicate or racemose, long or short, more or less interrupted; calyx cleft anteriorly or not, 5-dentate, the teeth equal to unequal, entire to serrate; corolla-tube as long as, to twice as long as the calyx, usually straight in the calyx, rarely slightly bending, erect or bending distally; galea with the apex either truncate, acute, or short- to long-beaked, dentate, or not so in the beakless species; lower lip usually broad, the lobes glabrous or ciliate on the margins, the middle lobe cucullate or not.

As a section, this embodies a number of series that probably represent a main line of evolution in the genus. The species comprising these series have mostly the normal habit, being erect, branching or not branching, and with petiolate, deeply pinnatifid to pinnatisect leaves. The corolla-tube is more or less erect in the calyx. The galea exhibits various modifications, such as the toothless, the toothed, the very short-beaked, and the very long- and slender-beaked conditions. In the last group, there are species with the beak strongly twisted to one side.

The section covers a wide area, from the eastern Himalayas and western China through Siberia to the Mediterranean region.

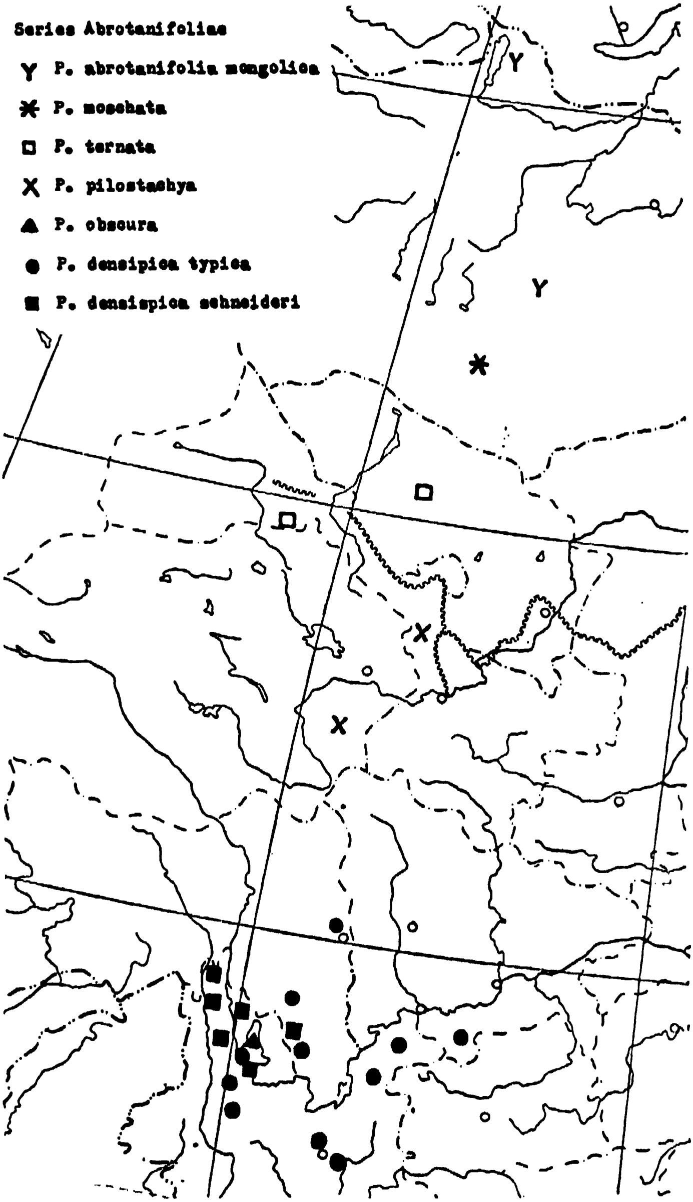
Series 1. Abrotanifoliae

Abrotanifoliae Limpricht, in Repert. Sp. Nov., 20: 209, 1924.

Low or tall erect plants, stems simple or branching at the base or above, glabrate to hirsute; leaves opposite or 3-4-verticillate, oblong-ovate to lanceolate, deeply pinnatifid to pinnatisect, the segments pinnatifid to serrate; flowers laxly or compactly arranged in spikes; calyx campanulate, membranaceous, cleft anteriorly or not cleft, more or less densely pubescent, 5-dentate, the teeth equal to subequal, deltoid to ovate, entire to serrate; corolla pink to red, sometimes yellow, the tube straight below in the calyx, bending forward distally above the calyx, the lower lip about the length of the galea or very slightly longer, the galea truncate at apex, entire; filaments glabrous or hairy.

About 13 species, from the Mediterranean region through Siberia to the Himalayas.

Limpricht gave the name Abrotanifoliae with a list of species but without a description for the series. In this he combined the series Ponticae, Pilostachyae, Gibberae, and Denudatae of Prain (in Ann. Bot. Gard. Calcutta, 3: 95-97. 1890). These groups of Prain are divided without precise limits and distinct differences, and it is thought that Limpricht's larger unit is more appropriate. The species *P. goniantha,* doubtfully included in this series by Limpricht, is found to be synonymous to *P. kansuensis* of the series Verticillatae. *P. ganpinensis* is also placed in the Verticillatae. The series, as at present defined, is widely distributed from the eastern Himalayan region in India to Yunnan, Sikang, northward to Kansu, Sinkiang, Mongolia, and through Siberia to the Mediterranean region (map 3).



Map. 3.—Distribution of the series Abrotanifoliae.

This series is apparently related to the series Rigidae and Melampyriflorae. To both, the vegetative characters of some of the species show close resemblance. The series Rigidae and Melampyriflorae differ from this series primarily in the presence of teeth on the galea. With the disappearance of the teeth, some of the species are very like those of this series.

In addition to the species enumerated below, Marquand (in Journ. Linn. Soc. Bot., 48: 212, 1929) recorded *Pedicularis mollis* Wall., List n. 415. 1829, ex Benth., Scroph. Ind., 53. 1835, from western Sikang. This is primarily a species of the Himalayas that does not extend farther eastward. For citations of western Himalayan specimens, see Pennell in Monogr. Acad. Nat. Sci. Phila., 5: 126, 1943.

Key to the Chinese Species

A. Leaves 4-verticillate, pinnatisect, divided deeply to the midrib, the segments linear, pinnatifid to serrate; flowers yellow to purple.
  B. Flowers yellow; calyx-teeth more or less deltoid, broadened at base, slightly serrate at the tip. .... 1. *P. abrotanifolia*
  BB. Flowers purple; calyx-teeth mostly ovate, narrowed below, distinctly serrate distally. .... 2. *P. moschata*
AA. Leaves opposite to 3-4-verticillate, divided less deeply, the segments ovate-oblong, pinnatifid or serrate; flowers rose to deep red.
  B. Leaves 3-verticillate; calyx covered densely with a grayish to whitish long tomentum; calyx-teeth deltoid to oblong-triangular, entire or nearly so; corolla deep red; staminal filaments all glabrous.
    C. Plant tall, over 30 cm. high; flowers more or less laxly arranged, the tomentum grayish; calyx-teeth oblong-triangular. .... 3. *P. ternata*
    CC. Plant low, less than 12 cm. high; flowers compactly arranged in a spike covered by dense whitish tomentum; calyx-teeth short, deltoid. 4. *P. pilostachya*
  BB. Leaves opposite to 3-4-verticillate; calyx pubescent; calyx-teeth ovate to ovate-oblong, serrate; corolla pink to red; staminal filaments glabrous or 2 of them hairy.
    C. All staminal filaments glabrous; lobes of the lower lip glabrous on the margins; leaves petiolate, the petioles 5-20 mm. long; calyx cleft anteriorly, its teeth broadly ovate. .... 5. *P. obscura*
    CC. Two of the staminal filaments hairy; lobes of the lower lip ciliate on the margins; leaves sessile to subsessile or short-petiolate, the petioles to 5 mm. long; calyx not cleft anteriorly, its teeth ovate-oblong. 6. *P. densispica*

1. **Pedicularis abrotanifolia** Bieberstein

Pedicularis abrotanifolia Bieb. ex Stev., in Mém. Soc. Nat. Mosc., 6: 22, pl. 5, fig. 1, 1823. "In Sibiria ulteriore (herb. Marschall. ex Pallas et Stephan)" Maximowicz (in Bull. Acad. St. Pétersb., 32: 592, fig. 104, 1888; in Mél. Biol., 12: 879, fig. 104, 1888) divided the species into two forms, α. *altaica* and β. *mongolica*. His α. *altaica* is evidently the typical form of the species as he cited the number "Pallas! in hb. Steph." His figure 104 consists of two drawings, the upper one apparently referred to α. *altaica* and the lower to β. *mongolica*.

Key to the Forms

A. Flowers slightly larger; galea protracted at the apex; lower lip about as long as the galea or very slightly longer; ovary ovate-oblong. .... 1a. *P. a. altaica*

AA. Flowers slightly smaller; galea more or less truncate at the apex; lower lip about ⅔ as long as the galea; ovary broadly ovate. .... 1b. *P. a. mongolica*

1a. Pedicularis abrotanifolia altaica

Pedicularis abrotanifolia M. Bieb. α. *altaica* Maxim., in Bull. Acad. St. Pétersb., 32: 592, fig. 104, 1888; in Mél. Biol., 12: 879, fig. 104, 1888.—Limpricht, in Repert. Sp. Nov., 20: 209, 1924. Maximowicz's types are: "*Sibiria altaica* (Pallas! in hb. Steph., Bunge!, Kar. Kir.! v. gr. ad Tschujam (Gebber!); *Songaria:* Alatau (Fetissow!, Kuschakewicz!); *Ural:* . . . ."

Siberia to Sinkiang. Flowers yellow. No specimen available from the latter region.

1b. Pedicularis abrotanifolia mongolica Maximowicz Plate 15, fig. 1.

Pedicularis abrotanifolia β. mongolica Maxim., in Bull. Acad. St. Pétersb., 32: 592, fig. 104, 1888; in Mél. Biol., 12: 879, fig. 104, 1888.—Limpricht, in Repert. Sp. Nov., 20: 209, 1924. Maximowicz's type was from: "Mongolia boreali-orientali: ad lacum Kossogol (Turczan!)." A specimen of *Turczaninow* s.n., collected in 1830, in the herbarium of the Academy of Natural Sciences of Philadelphia, is apparently an isotype.

Northern Mongolia. Flowers yellow.

MONGOLIA: Lake Kossogol, *Turczaninow* s.n. (ANSP), *Komarov* s.n. (UCLA); Khangai, on the gravel in the valley of Upper Chulute, *Pavlov* 1112 (NYBG).

2. Pedicularis moschata Maximowicz Plate 15, fig. 2.

Pedicularis moschata Maxim., in Bull. Acad. St. Pétersb., 27: 516, 1881; 32: 592, fig. 105, 1888; in Mél. Biol., 11: 216, 1881; 12: 880, fig. 105, 1888.—Limpricht, in Repert. Sp. Nov., 20: 209, 1924. Maximowicz's types were from: "*Mongolia* borealis: Altai australis pluribus locis (Potanin, 1877)." In the Bonati Herbarium, there is a single specimen (ex Herb. Petrop.) bearing Maximowicz's handwriting reading: "*Pedicularis moschata* Maxim. Mongolia septentr. Jugum Altai australis. Ad fontes fluvii Tatan. Legit G. N. Potanin, 8 VII, 1877. Determ. Maximowicz." It is clearly one of the syntypes that had been examined by the author in making the original description. It passes to the University of California at Los Angeles but a photograph will remain at the Academy of Natural Sciences of Philadelphia.

In southern Altai, Mongolia. Flowers purple. Flowering in July.

MONGOLIA: southern Altai, *Potanin* s.n. (B).

3. Pedicularis ternata Maximowicz Plate 15, fig. 3.

Pedicularis ternata Maxim., in Bull. St. Pétersb., 24: 64, 1878; 32: 592, fig. 108, 1888; in Mél. Biol., 10: 98, 1877; 12: 880, fig. 108, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 218, 1890; Limpricht, in Repert. Sp. Nov., 20: 209, 1924. Maximowicz's type: "Mongolia australi: jugo Alaschan sylvis humidis regionis superioris frequens (Przewalski)," has not been seen. An authentic specimen, *Przewalski* s.n., from Kansu, cited by Maximowicz in 1888, is in the Bonati Herbarium.

At altitudes of 3200 to 4550 meters, from southern Mongolia to western Kansu and Chinghai. Flowers deep red. Flowering in July.

KANSU: Nanshan, near Rakogol River, *Przewalski* s.n. (UCLA).

4. Pedicularis pilostachya Maximowicz Plate 15, fig. 4.

Pedicularis pilostachya Maxim., in Bull. Acad. St. Pétersb., 24: 64, 1878; 32: 593, fig. 109, 1888; in Mél. Biol., 10: 99, 1878; 12: 881, fig. 109, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 213, 1890; Limpricht, in Repert. Sp. Nov., 20: 209, 1924;

Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933. Maximowicz's type was from Kansu: "In Chinae prov. Kansu, cacumine alpis Sadi Soruksum alt. 13,500 ped. (Przewalski)." In the Bonati Herbarium there is a single specimen (ex Herb. Petrop.) of *P. pilostachya* with the label: "Prov. Kansu, China, 21 VII, 1872. Jugum S. a fluvio Tetung (Te Datung-che). Legit N. M. Przewalski. Det. Maximowicz." The handwriting is that of Maximowicz. It may be that this belongs to the type collection, although I cannot account for the different labels, or, if otherwise, the reason why Maximowicz did not cite this collection. Anyway this is an authentic specimen which had been examined by the original author of the species most probably before the actual publication of his description.

Gravelly slopes on top of mountains, at altitudes of 4720 to 5070 meters, in western Kansu and eastern Chinghai. Flowers deep carmine. Flowering in June and July.

KANSU: near Ta-tung River, *Przewalski* s.n. (UCLA); Da-tung, *Farrer* 712 (RBGE). CHINGHAI: Jupar Range, on summit Jupar tsargen, *Rock* 14331 (ANSP, GH, NYBG, USNH).

A very striking plant with deep carmine flowers and densely and thickly grayish-pubescent spikes. The calyx is covered by a heavy villose tomentum. In this respect, it is particularly closely related to *P. ternata*, but the latter is less pubescent. Prain (in Ann. Bot. Gard. Calcutta, 3: 95-96, 1890) made these two species into a separate series Pilostachyae.

5. **Pedicularis obscura** Bonati Plate 15, fig. 5.

Pedicularis obscura Bonati, in Notes Bot. Gard. Edinb., 15: 149, 1926; Limpricht, in Repert. Sp. Nov., 23: 334, 1927. Bonati's type was from: "'Yunnan: Yangtze watershed, Prefectural District of Likiang, eastern slopes of Likiang Snow Range. 12-14,000 ft. Flowers pink. June 1922.' J. F. Rock. No. 4480." An isotype is in the United States National Herbarium.

At altitudes of 3660 to 4270 meters, in Likiang, northwestern Yunnan. Flowers pink. Flowering in June. Known from the original collection only.

YUNNAN: eastern slopes of the Likiang Snow Range, *Rock* 4480 (USNH).

This species is close to *P. densispica*. It differs in being a lower plant, in the leaves being long-petiolate, in the lower lip being not ciliate on the margins, and in the filaments being all glabrous.

6. **Pedicularis densispica** Franchet

Key to the Varieties

A. Plant less than 3 dm. high, more or less hirsute; bracts as long as or shorter than the flowers; corolla with the lower lip about as long as the galea. 6a. *P. d. typica*

AA. Plant tall, 4 dm. or more high; bracts patent or reflexed, 2 or 3 times as long as the flowers; corolla with the lower lip slightly longer than the galea. 6b. *P. d. schneideri*

6a. **Pedicularis densispica typica** Plate 15, fig. 6.

Pedicularis densispica Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 594, fig. 111, 1888; in Mél. Biol., 12: 882, fig. 111, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 208, 1890; Bonati, in Bull. Herb. Boiss. II, 7: 545, 1907, and in Notes Bot. Gard. Edinb., 5: 90, 1911; 7: 120, 152, 242, 1912; 8: 43, 1913; and 15: 150, 1926;

Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; 20: 209, 1924; 23: 334, 1927; Marquand, in Journ. Linn. Soc. Bot., 48: 212, 1929; Hand-Maz., Symb. Sin., 7: 850, 1936. Franchet's type was from: "Yunnan, pascuis elatis montis Tsang-chan supra Tali (Delavay! in herb. Paris.)." In the Bonati Herbarium there are two Delavay numbers. One sheet has a single specimen, *Delavay* 2778 (ex Mus. Berol.), collected in Yunnan, Hee-chan-men, July 15, 1887, and labelled: "*Pedicularis densispica* Franch. ined.," but apparently not in Franchet's handwriting. Another is *Delavay* s.n. (ex Herb. Mus. Paris), a sheet with four specimens but without exact locality, bearing only Franchet's handwriting, identified as *Pedicularis densispica*. This second sheet may be a duplicate of the first one, or it may be an isotype.

Pedicularis magnini Bonati, in Notes Bot. Gard. Edinb., 15: 149, 1926; Limpricht, in Repert. Sp. Nov., 23: 334, 1927. Bonati's type was from: "'Yunnan: Between Lashipa and Nguluke. Alt. 8,500 ft. High plateau between Talifu and Likiang to the foot of the Likiang Snow Range. Flowers purple. May 1922.' J. F. Rock No. 3307." An isotype is in the United States National Herbarium. It proves to be identical with *P. densispica typica*.

Alpine pastures at altitudes of 1880 to 3000 meters, in northern Yunnan, southern Szechuan, and southeastern Sikang. Flowers rose to purple. Flowering from April to July.

SZECHUAN: Juei-she District, *Yü* 938 (GH), 1042 (GH).

SIKANG: Ta-tsien-lou, *Soulié* 578 (ANSP, UCLA); Muli, *Forrest* 21399 (UC, USNH), 28425 (ANSP);; between Hunpa and Woloho, *Schneider* 1524 (USNH); Konkaling, *Yü* 13267 (AA).

YUNNAN: no locality, *Delavay* s.n. (UCLA), *Maire* s.n. (ANSP, UCLA), *Yü* 9860 (AA), 11700 (AA); Hee-chan-men, *Delavay* 2778 (UCLA); La-kon, *Maire* s.n. (GH); Tongtchouan, *Maire* s.n. (ANSP, UCLA), 6379 (ANSP, UCLA); Yunnan sen, *Ducloux* 899 (ANSP, UCLA, USNH), 5709 (NYBG, USNH); Hay y, Lon lan, *Ducloux* 693 (ANSP, ULCA); eastern flank of the Tali Range, *Forrest* 4503 (ANSP, UCLA); between Likiang and Tali, *Rock* 3307 (USNH); Ta-li District, *Tsai* 53809 (AA); Likiang Range, *Forrest* 2061 (ANSP, UCLA), 6209 (UCLA), 6256 (UCLA); eastern flank of the Likiang Snow Range, *Rock* 3646 (GH, NYBG, USNH), 4760 (ANSP, UC, USNH); Likiang District, *C. W. Wang* 65024 (AA); Likiang Snow Range, *Feng* 669 (AA), *Ching* 20998 (AA), 20999 (AA), 30052 (AA); Cheng-kiang, Wat-shih-han, *H. Wang* 41619 (AA); Yi-liang District, *Tsai* 52155 (AA), 52175 p.p. (AA).

6b. Pedicularis densispica schneideri

Pedicularis densispica Franch. var. *schneideri* Bonati, in Notes Bot. Gard. Edinb., 13: 133, 1921; 15: 150, 1926; Limpricht, in Repert. Sp. Nov., 20: 210, 1924; Hand.-Maz., Symb. Sin., 7: 850, 1936. Bonati's type, "'Yunnan, in pratis humidis inter Yungpeh-ting et Taowang; fils. rosei. Alt. 2,400 m. Jul. 1914.' Camillo Schneider. No. 1710. Inter Chinense, 1914, Societatis dendrologicae Austriae et Hungeriae," has not been seen. Some of the Rock specimens cited were identified by Bonati as representing this variety.

Alpine meadows at altitudes of 2750 to 4270 meters in northwestern Yunnan and southeastern Sikang. Flowers purple to red. Flowering from June to August.

SIKANG: Muli Territory, mountains of Kulu, *Rock* 18053 (ANSP, USNH); Muli Territory, western slopes of Mt. Mitsuga, *Rock* 23987 (NYBG, UC, UP), 24550 (NYBG, UC, UP); Leilung, Kaushu Shan, *Rock* 24506 (NYBG, UC, UP).

YUNNAN: no locality, *Yü* 7390 (AA); eastern slopes of Likiang Snow Range, *Rock* 4502 (ANSP, UC, USNH), 4898 (USNH), 4961 (USNH), 4980 (USNH), 5718 (GH, USNH); Likiang, *Schneider* 3262 (GH); Likiang Snow Range, *Ching* 30411 (AA); Chetse-lo, *Tsai* 58076 (AA); Wei-si District, Yeh-chih, *C. W. Wang* 68167 (AA); A-tung-tse, *C. W. Wang* 70346 (AA); Chung-tien Valley, *Feng* 1678 (AA); Chung-tien Plateau, *Yü* 13608; Chung-tien, Tungwahlung, *Yü* 13591 (AA); Muli, Wachin, *Yü* 14408 (AA).

Among the specimens cited, *Rock* 24550 and *Wang* 70346 are in fruit. The fruits are about 1.1-1.3 cm. long and 5-7 mm. wide, acuminate, and open on the inner side toward the apex.

Bonati said of this variety: " This differs from *P. densispica* Franch. by its taller habit, 40 cm. or more, its leaves verticillate in fours, patent or reflexed, 40-45 mm. long, about 20 mm. broad, its bracts much more elongate, patent or reflexed, two or three times as long as the flowers, its calyx with segments longer stalked and itself 10-12 mm. long, its corolla about 15 mm. long, and finally by its staminal filaments being all hairy." However, in the specimens studied, only two of the filaments are found to be hairy, similar to the condition found in the typical form of the species. In addition to the characters enumerated by Bonati, this plant appears to be further differentiated from the typical form by its nearly glabrate habit except in the inflorescences, by its being frequently short-branched above, and by the lower lip of its corolla being slightly longer than the galea.

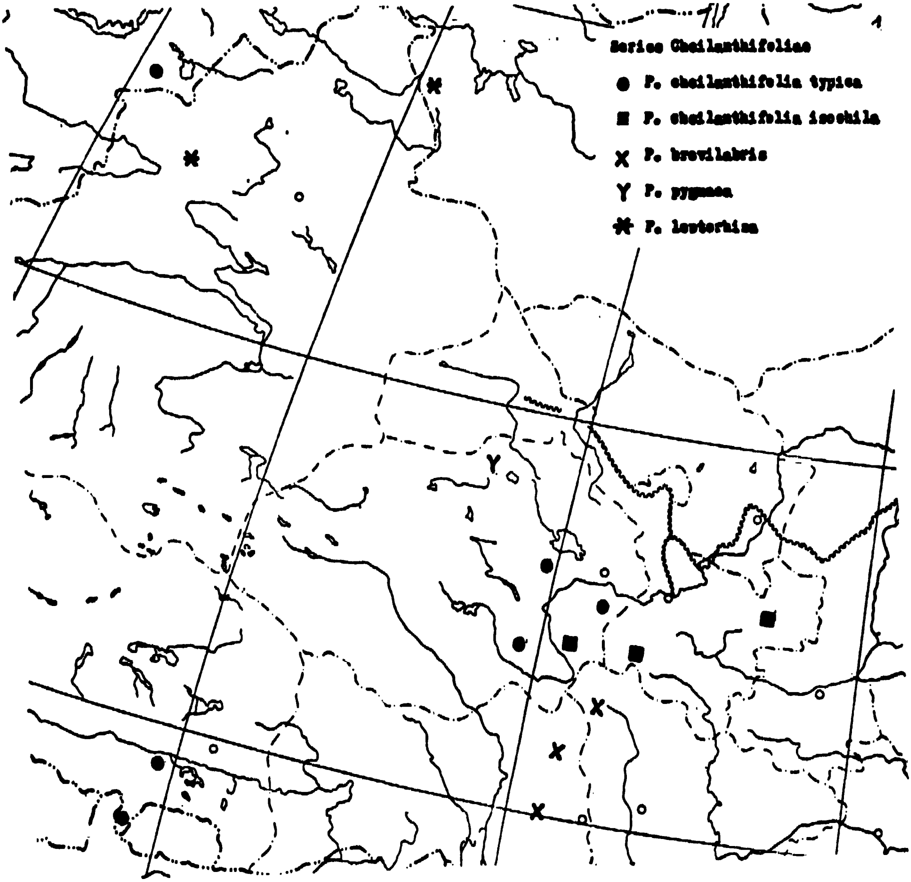
Series 2. Cheilanthifoliae

Cheilanthifoliae Maxim., in Bull. Acad. St. Pétersb., 32: 581, 1888; in Mél. Biol., 12: 863, 1888, p.p.; Prain, in Ann. Bot. Gard. Calcutta, 3: 93, 1890.

Low or tall plants, usually branched at base, pubescent or glabrate; leaves radical and cauline, the radical long-petiolate, the cauline 4-verticillate, ovate-oblong to lanceolate, pinnatisect to deeply pinnatifid, the segments ovate-lanceolate to linear, dentate; calyx campanulate, membranaceous, hirsute, unequally 5-dentate, the teeth short, deltoid to ovate-oblong, entire or dentate; corolla-tube erect or very slightly bending in the calyx, erect distally; galea erect at base, its apex with a short broad beak-like tip; lower margin entire; filaments villose or glabrous.

This series was first established by Maximowicz, and later redefined by Prain. According to Limpricht, the series contains, in addition to the three Chinese species listed below, two species from the western and eastern Himalayas respectively, and one from northwestern North America. *P. brevilabris*, included by Limpricht in the series Microchilae, is here placed in the series Cheilanthifoliae. *P. pygmaea*, included by Limpricht in the series Amoenae which is herewith combined with the series Verticillatae, is also transferred to this series. *P. leptorhiza* was included in the series Denudatae by Prain (op. cit. 96), together with *P. abrotanifolia*, etc., but it appears that the species is more properly placed here as was done by Maximowicz.

The Chinese species of the series are found in Kansu, Chinghai, westward to Sikang and western Tibet (Map 4).



Map. 4.—Distribution of the series Cheilanthifoliae.

In addition to the species enumerated below, another species, *P. svenhedinii* Paulsen,[18] a recent segregate from *P. cheilanthifolia* described from extreme southwestern Tibet, is essentially a western Himalayan plant and so not considered here. For citation of specimens from western Himalaya in the several herbaria, see Pennell, in Acad. Nat. Sci. Phila. Monogr., 5: 123, 1943.

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[18] *Pedicularis svenhedinii* Paulsen, in Sven Hedin, Southern Tibet, 6 (3): 44, fig. 2 & pl. 7, 1921. "S.W. Tibet. Height above the source of Tsangpo, northern foot of Himalaya, 5015 m., 13th July 1907 [*Sven Hedin*]."

Key to the Chinese Species

A. Corolla slightly bent in the calyx, the tube 1 to 1½ times as long as the calyx; the beak-like apex of the galea very short, truncate; staminal filaments glabrous or only very slightly villose at base.
  B. Flowers large, over 1.5 cm. long; corolla-tube about 1½ times as long as the calyx; galea as long as the lower lip or much longer.
    C. Leaves pinnatisect, the rachis hardly 1 mm. wide, the segments linear to lanceolate; calyx slightly cleft in front, the teeth deltoid, not narrowed at base, entire or obscurely dentate; corolla about 2.5 cm. long. 7. *P. cheilanthifolia*
    CC. Leaves deeply pinnatifid, the rachis about 2 mm. wide, the lobes ovate-oblong, acutely dentate; calyx not cleft anteriorly, the teeth deltoid to ovate-oblong, subentire to acutely dentate, some narrowed at base; corolla about 1.5-2 cm. long. .... 8. *P. brevilabris*
  BB. Flowers small, less than 1 cm. long; corolla-tube only slightly longer than the calyx; galea shorter than the lower lip. .... 9. *P. pygmaea*

AA. Corolla erect in the calyx, the tube about 3 times as long as the calyx; galea about as long as the lower lip; apex of the galea with a longer beak-like ending, slightly deflexed; two of the filaments sparsely villose. .... 10. *P. leptorhiza*

7. Pedicularis cheilanthifolia Schrenk

Two varieties are distinguished by Maximowicz and Prain. These seem geographically more or less distinct. The var. *typica* is distributed toward the west, from western Kansu to Chinghai, Sinkiang, western Tibet, and western Himalaya. The var. *isochila* is found in eastern and southern Kansu and adjacent northwestern Chinghai.

Key to the Varieties

A. Galea about 10 mm. long, longer than the lower lip; lower lip about 8 mm. long and 10 mm. wide; flowers pale pink to white (turning yellow on drying). 7a. *P. c. typica*

AA. Galea 10 mm. long, about as long as the lower lip; lower lip about 10 mm. long and 12 mm. wide; flowers yellow. .... 7b. *P. c. isochila*

7a. Pedicularis cheilanthifolia typica Plate 15, fig. 7.

Pedicularis cheilanthifolia Schrenk, in Bull. Phys.-Math. Acad. St. Pétersb., 1: 79, 1842; in Fisch. & Mey., Enum. Alt. Pl. Nov. Schrenk, 2: 19, 1842; Benth., in DC. Prodr., 10: 562, 1846; Maxim., in Bull. Acad. St. Pétersb., 24: 58, 1878; 32: 584, 1888; in Mél. Biol., 10: 89, 1878; 12: 868, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 206, 1890; Diels, in Futterer, Durch Asien, 3: 20, 1911; Marquand, in Journ. Linn. Soc. Bot., 48: 20, 1921; Limpricht, in Repert. Sp. Nov., 20: 211, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 32, 1933; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 210, 1934. Schrenk's type, "Lecta in Monte Ispuli [Songaria], d. 16 Julii m.," has not been seen.

Pedicularis cheilanthifolia Schrenk var. *typica* Prain, in Ann. Bot. Gard., Calcutta, 3: 171, 1890; Limpricht, in Repert. Sp. Nov., 20: 211, 1924.

Grassy mountain slopes or banks of streams, at altitudes of 3000 to 4900 meters, from Chinghai, western Sinkiang, northern Tibet, to western Himalaya. Flowers pale pink or white. Flowering in June and July.

CHINGHAI: Ba Valley, *Rock* 14272 (ANSP, GH, NYBG); eastern slopes of Wago Kandom pass, between Labrang and Yellow River, *Rock* 14465 (ANSP); Wanchennang Valley, between Labrang and Yellow River, *Rock* 14526 (ANSP, GH, USNH).

TIBET: northern Tibet, *Przewalski* s.n. (B); Gyantse, *Cutting & Vernay* 41 (GH); near Shigatse, *Cutting & Vernay* 114 (GH); Phari, *Chapman* 773 (GH).

7b. Pedicularis cheilanthifolia isochila

Pedicularis cheilanthifolia Schrenk var. *isochila* Maxim., in Bull. Acad. St. Pétersb., 32: 585, 1888; in Mél. Biol., 12: 869, 1888; Limpricht, in Repert. Sp. Nov., 20: 211, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 32, 1933. Maximowicz's types were from: "Kansu occidentali: valle fl. Runwyr infra monasterium ejusdem nominis, 'flores odore debili moschi'; ejusdem provinciae parte orientali: monte Yalissan prope pagum Katapu (Potanin, 1885)." Isotypes are in the Bonati Herbarium and the herbarium of the Academy of Natural Sciences of Philadelphia. They are labelled: "China, Prov. Kansu orientali 11 VI, 1885. Legit G. N. Potanin. Det. Maximowicz." In spite of the difference in the label these clearly belong to the type collections. This is exactly as cited by Prain (in Ann. Bot. Gard. Calcutta, 3. 171, pl. 32 C, 1891).

Grassy slopes of mountains or grassy banks of rivers, at altitudes of 2600 to 3850 meters, in eastern to southwestern Kansu and northeastern Chinghai. Flowers yellow. Flowering in June.

KANSU: eastern Kansu, *Potanin* s.n. (ANSP); southwestern Kansu, along T'ao River, *Rock* 12247 (ANSP, CM, GH, UC), 12278 (ANSP, GH, USNH), 12312 (ANSP, GH).

CHINGHAI: Radja and Yellow River Gorges, *Rock* 14202 (ANSP, GH, NYBG); Kokonor, north shore, *Farrer* s.n. (RBGE).

8. Pedicularis brevilabris Franchet Plate 15, fig. 8.

Pedicularis brevilabris Franch., in Bull. Soc. Bot. France, 47: 33, 1900; Bonati, in Bull. Herb. Boiss., II, 7: 545, 1907; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; 20: 208, 1924; Hand.-Maz., Symb. Sin., 7: 850, 1936. Franchet's types, "Su-tchuen, autour de Ta-tsien-lou (Soulié, nos. 208, 236, 226)," have not been seen. The number here cited was identified by Bonati and agrees closely with Franchet's original description.

Eastern Sikang to northwestern Szechuan.

SIKANG: Tongolo, *Soulié* 2855 (ANSP, UCLA).

When Franchet first described this species, he compared it with *P. microchila.* Limpricht (l.c. 1924) accordingly included it in the series Microchilae of Prain together with *P. microchila.* However, this species differs considerably from the latter and is not closely related. The leaves are much more deeply pinnatifid. The corolla is more or less straight, the galea ending in a very short beak-like apex, and the anther-pairs are contiguous; while in *P. microchila* the corolla is strongly deflexed between the tube and the galea, the galea is rounded at apex and without any protruded ending, and the anther-pairs are discrete. The characters of *P. brevilabris* clearly indicate that it should be included in the series Cheilanthifoliae.

9. Pedicularis pygmaea Maximowicz

Pedicularis pygmaea Maxim., in Bull. Acad. St. Pétersb., 32: 595, fig. 114, 1888; in Mél. Biol., 12: 885, fig. 114, 1888; Limpricht, in Repert. Sp. Nov., 20: 208, 1924. Maximowicz's type, "*Tibet* boreali: decursu medio fl. Dschagyn gol, ripa graminosa limosa frequens (Przewalski, 1884)," has not been seen.

In northern Chinghai. Flowers rose. Known from the original collection only. No specimen seen.

The species was originally included in the series Abrotanifoliae by Maximowicz but was made into a series of its own, Pygmaea, by Prain (in Ann. Bot. Gard. Calcutta, 3: 95, 1890). Limpricht included it in the series Amoenae which is here combined with the series Verticillatae. From the description and the excellent illustration given by Maximowicz, this species appears to be more appropriately placed in the series Cheilanthifoliae, as evidenced particularly by the short beak-like apex of its galea.

10. **Pedicularis leptorhiza** Ruprecht

Pedicularis leptorhiza Rupr., in Mém. Acad. St. Pétersb., VII, 14 (4): 62, 1869; Maxim., in Bull. Acad. St. Pétersb., 32: 581, fig. 92, 1888; in Mél. Biol., 12: 864, fig. 92, 1888; Limpricht, in Repert. Sp. Nov., 20: 211, 1924. Ruprecht's type, "20 Jul. fl.," was collected by Osten-Sacken. Maximowicz, apparently referring to the type collection, cited, "*Thian-schan:* fauce Dshaman-daban, regione subalpina, 1 Aug. 1867 fl. defl. (Osten-Sacken!)." A detailed description was therein also added.

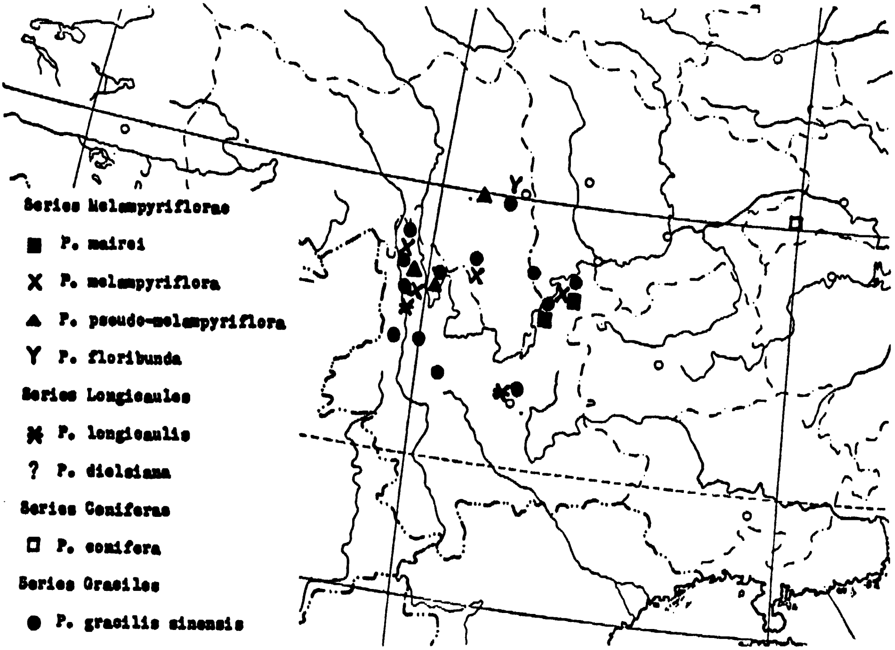
From the Tien-shan region in Sinkiang to Siberian Turkestan. Flowers purple (?). No specimen seen.

Series 3. Melampyriflorae

Melampyriflorae Prain, in Ann. Bot. Gard. Calcutta, 3: 86, 1890 (as "Melampyrifoliae").

Plants erect, robust, the stem rigid, usually branching above; leaves 4-verticillate, the lower or upper sometimes opposite, pinnatisect, the segments ovate-oblong to lanceolate, pinnately lobed; calyx cylindrical, 5-dentate, the teeth equal to unequal, deltoid to ovate, entire or serrate; corolla-tube longer than the calyx; galea about as long as the lower lip, rounded to slightly crested in front, the apex usually ending in a broad very short beak, with one tooth on each side of the lower margin; filaments glabrous or hairy.

When Prain first established the series, it contained only *P. melampyriflora*. In 1911, Bonati (in Bull. Bot. Soc. France, 57, Mém. 18: 29, 1911) presented a key to the species of the series, including, in addition to *P. melampyriflora*, also *P. floribunda*, *P. mairei*, and *P. pseudomelampyriflora* (*P. elegans* Franch.), all from southwestern China. In 1921 (in Notes Bot. Gard. Edinb., 13: 140, 1921) his key was elaborated to include three new species from Upper Burma, raising the total number to seven. These seven species were accepted for the series by Limpricht in his enumeration (in Repert. Sp. Nov., 20: 225, 1924). The range of the series is in the northern part of Upper Burma, northern Yunnan, eastern Sikang, and southern Szechuan (Map 5).



Map. 5.—Distribution of the series Melampyriflorae, Longicaules, Coniferae, and Graciles.

Key to the Chinese Species

A. Plant glabrous or slightly hairy; leaves fleshy, pinnatisect, with linear segments; calyx cleft anteriorly, the teeth unequal, deltoid, entire, the posterior ones larger; corolla-tube strongly bent; staminal filaments all glabrous. .... 11. *P. mairei*

AA. Plants hairy, sometimes very shaggy; leaves more or less membranaceous, pinnatisect, with ovate-oblong to ovate-lanceolate segments; calyx not cleft anteriorly, the teeth equal to unequal, ovate, serrate, the posterior one often smaller; corolla-tube slightly bent; staminal filaments glabrous or hairy.

B. Galea not crested in front; calyx-teeth equal or nearly so; corolla-tube about 3 times as long as the calyx; staminal filaments all glabrous. 12. *P. melampyriflora*

BB. Galea slightly crested in front; calyx-teeth unequal, the posterior one smaller; corolla-tube about 2-2½ times as long as the calyx; 2 or all of the staminal filaments hairy.

C. Plant very large, shaggy; flowers large, with corolla about 2.5 cm. long, the teeth subulate; calyx-teeth more or less narrowed proximally; 2 of the staminal filaments hairy. .... 13. *P. pseudomelampyriflora*

CC. Plant smaller, less hairy; flowers smaller, with corolla about 2 cm. long, the teeth deltoid; calyx-teeth slightly narrowed proximally; all staminal filaments hairy. .... 14. *P. floribunda*

11. Pedicularis mairei Bonati Plate 15, fig. 9.

Pedicularis mairei Bonati, in Bull. Soc. Bot. France, 57, Sess. Extraord.: lix, 1911; Limpricht, in Repert. Sp. Nov., 20: 226, 1924. Bonati's type: "*Yunnan:* Ta-ho-ty, region de Kiao-kia (*Siméon Ten,* collect. chinois, *Ducloux,* no. 984)," was in the

Bonati Herbarium; the type passes to the University of California at Los Angeles, with isotype at the Academy of Natural Sciences of Philadelphia. The type locality is in northeastern Yunnan on the Yangtse River close to the Szechuan border.

Dry situations and pastures on mountain sides at altitudes of 2500 to 2600 meters, in northeastern Yunnan. Flowers rose. Flowering from July to September.

YUNNAN: Ta-ho-ty, Kiao Kia, *Ducloux* 984 (ANSP, UCLA); Tong-tchouan, *Ducloux* 1540 (ANSP, UCLA); La Kou, *Maire* s.n. (ANSP, UCLA); Pan-tong-se, *Maire* 7418 (ANSP, UCLA); Pan-pien-kai, *Maire* s.n. (ANSP, UCLA), 6139 (ANSP, UCLA).

This species differs strikingly from other species of the series in its totally glabrous habit, its more or less fleshy leaves with linear segments, and its anteriorly cleft calyx. Bonati described the calyx as 5-6 mm. long and the corolla as 2-3 cm. long with a tube of 8-10 mm. long. But actually, in the type specimens, the corolla-tube measures about 12-16 mm. long, being a little more than twice the length of the calyx and slightly longer than the galea.

12. Pedicularis melampyriflora Franchet Plate 15, fig. 10.

Pedicularis melampyriflora ("*melampyrifolia*") Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 603, fig. 132, 1888; in Mél. Biol., 12: 896, fig. 132, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 212, 1890; Limpricht, in Repert. Sp. Nov., 20: 225, 1924; Hand.-Maz., Symb. Sin., 7: 854, 1936. Franchet's type, "Yunnan, ad pedem montis Yang-in-chan prope Lankong (Delavay! in herb. Paris)," has not been seen. The name was originally published as "melampyrifolia." This was corrected by Forbes and Hemsley who cited the same number of Delavay (from herb. Kew) and gave the name as "*Pedicularis melampyriflora, Franchet* ex *Maxim., in Mél. Biol.,* xii. p. 896 (ubi sphalmate melampyrifolia, *fide* Franchet in sched.), n. 168."

On mountain slopes, at altitudes of 2700 to 3600 meters, in northern Yunnan and southern Sikang. Flowers rose to purple. Flowering in July and August.

SIKANG: Muli Kingdom, mountains between the Litang and Shou-Chu Rivers, between Wa-Erh-Dje and Garu, *Rock* 16739 (ANSP, USNH).

YUNNAN: Tapin tse, *Delavay* 2764 (ANSP, UCLA), 4977 (UCLA); A-tung-tse, *C. W. Wang* 70027 (AA), 70302 (AA); no locality, *Yü* 13237 (AA).

ASIA: no locality, *Komarov* s.n. (UCLA).

Among the collections cited, *Wang* 70027 is a fruiting specimen, and *Wang* 70302 bears both fruits and a few somewhat withered flowers. The fruits are compressed ovoid, obliquely sharp-pointed, about 1 cm. long and 6 mm. wide, dehiscing posteriorly on the distal half.

13. Pedicularis pseudomelampyriflora Bonati Plate 15, fig. 11.

Pedicularis elegans Franch., in Bull. Soc. Bot. France, 47: 32, 1900; Limpricht, in Repert. Sp. Nov., 20: 205, 1924; *non* Tenore (1831). Franchet's type, "Su-tchuen: autour de Ta-tsien-lou (Mussot, n. 303)," has not been seen. This name is preoccupied by *P. elegans* Tenore, an Italian species.

Pedicularis pseudomelampyriflora Bonati, in Bull. Soc. Bot. France, 57, Mém. 18: 29, 1910, *nomen subnudum;* in Notes Bot. Gard. Edinb., 15: 155, 1926; Limpricht, in

Repert. Sp. Nov., 20: 226, 1924; 23: 335, 1927. The name was first published by Bonati in key contrast only, without any citation of specimens or reference to other name, and may be considered as *nomen subnudum*. In 1926, he cited *Rock* 5771 as representing this species, giving at the same time *P. elegans* Franch. in synonymy. In the Bonati herbarium there are two collections, *Soulié* 3757 & 3758, bearing Bonati's identification as *P. elegans* Franch. On the label of the former, he indicated that the name ought to be changed because of the earlier *P. elegans* Tenore. Limpricht in 1924 listed both *P. elegans* Franch. and *P. pseudomelampyriflora* as valid species, citing *Mussot* 303 and *Forrest* 10965 respectively for the two species. In 1927, following Bonati, he corrected the names by accepting *P. pseudomelampyriflora* Bonati and placing *P. elegans* Franch. in synonymy.

Open moist situations on the margins of thickets, at altitudes of 3050 to 3660 meters, in eastern Sikang and northwestern Yunnan. Flowers rose. Flowering in July and August.

SIKANG: Yargong, *Soulié* 3757 (ANSP, UCLA), 3758 (UCLA).

YUNNAN: Tong Shan in the Yangtze bend, *Forrest* 10965 (ANSP, UCLA); eastern slopes of the Likiang Snow Range, *Rock* 5771 (ANSP, UC, USNH); no locality, *Yü* 7592 (AA).

14. Pedicularis floribunda Franchet Plate 15, fig. 12.

Pedicularis floribunda Franch., in Bull. Soc. Bot. France, 47: 31, 1900; Bonati, in Bull. Herb. Boiss., II, 7: 545, 1907; Limpricht, in Repert. Sp. Nov., 20: 226, 1934; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 212, 1934. Franchet's types were from "Sutchuen, Tongolo (Soulié, nos 518, 452)." In the Bonati Herbarium there in a single specimen, *Soulié* 518, of 1893, ex herb. Paris, evidently an isotype, but with the label reading as from Ta-tsien-lou. Both Tongolo and Ta-tsien-lou (Kanting) are now parts of Sikang Province.

In Sikang. Flowers rose. Also recorded from Shensi (ex Pai, l.c.).

SIKANG: Ta-tsien-lou, *Soulié* 518 (ANSP, UCLA).

This species appears to be particularly close to *P. pseudo-melampyriflora* both in general appearance and in floral structure. It is, however, a less robust plant, and with more scanty pubescence. The leaves as well as the flowers are smaller. Technically, the two species can be separated by their characters in the corolla-teeth, calyx-lobes, and staminal filaments as indicated in the key.

Series 4. Longicaules

Longicaules Prain, in Ann. Bot. Gard. Calcutta, 2: 85, 1890.

Tall plants; stems diffusely long-branched, the stems and branches slender, slightly hirsute, the branches opposite to 3-4-verticillate, spreading or ascending; leaves all cauline, 4-verticillate or sometimes opposite and ternate, subsessile to very short-petiolate, elliptic, deeply pinnatifid, the lobes pinnatifid and dentate; flowers axillary along the upper part of the branches; calyx membranaceous, campanulate, profoundly dentate, the teeth ovate, equal, narrowed below, incised dentate above; corolla pink, the tube twice as long as the calyx, straight below, slightly bending above the calyx; galea produced into a distinct long beak; lower lip about as long as the galea, the lateral lobes rounded, the mid-anterior much smaller, distal and acuminate; filaments glabrous.

This series was based upon a single species, *P. longicaulis*, peculiar to northern Yunnan. To that is now added *P. dielsiana*, of uncertain distribution and formally placed in the series Coniferae. It has the same small but long acuminate mid-anterior lobe of the lower corolla-lip, as well as long branches, as characterize *P. longicaulis*. (Map 5.)

Key to the Species

A. Flowers much larger; calyx-lobes equal, broad, serrate; corolla purple, about 2.2 cm. long, the beak long, slender, about 2.5 mm. or more long. .. 15. *P. longicaulis*

AA. Flowers smaller; calyx-lobes unequal, the posterior oblong-triangular, the others ovate, serrate; corolla yellow, about 1.5 cm. long, the beak short, scarcely 1.5 mm. long. .... 16. *P. dielsiana*

15. Pedicularis longicaulis Franchet Plate 16, fig. 13.

Pedicularis longicaulis Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 577, fig. 84, 1888; in Mél. Biol., 12: 858, fig. 84, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 211, 1890; Bonati, in Notes Bot. Gard. Edinb., 15: 162, 1926; Limpricht, in Repert. Sp. Nov., 20: 243, 1924; 23: 337, 1927; Hand.-Maz., Symb. Sin., 7: 860, 1936. Franchet's type, "Yunnan, in dumetis ad Mao-kou-tchang supra Ta-pin-tse Delavay! in herb. Paris.)," has not been seen. The description and illustration given by Maximowicz are distinctive.

At altitudes of 3660 to 3880 meters, in northern Yunnan. Flowers pink. Flowering from August to October.

YUNNAN: Tong-tchouan, *Maire* s.n. (USNH); Yunnan sen, *Maire* 1341 (UC); Hsi Shan, *Schoch* 277 (USNH); Yangtze watershed, eastern slopes of Likiang Snow Range, *Rock* 5690 (ANSP, UC, USNH).

A species characterized by its long-branched habit. *Maire* s.n. cited above has much smaller leaves than the rest, but is undoubtedly of the same species, which is probably variable with regard to vegetative characters. In general appearance it suggests *P. salviaeflora*, an unrelated species that is otherwise very different.

16. Pedicularis dielsiana Bonati Plate 16, fig. 14.

Pedicularis dielsiana Bonati, in Bull. Soc. Bot. France, 54: 186, 376, 1907; Limpricht, in Repert. Sp. Nov., 20: 243, 1924. Bonati's type, "[Wilson] No. 4346 [recueillie en 1904 dans le centre de la Chine]," is evidently an error for *Wilson* 4246, the number that appears on the isotype (ex Herb. Kew) in the Bonati Herbarium that passes to the University of California at Los Angeles; of this a photograph is at the Academy of Natural Sciences of Philadelphia. Limpricht erred also in following Bonati's citation. Bonati first described (l.c. 186) his species in French, and placed it in the series Myriophyllae. He redescribed (l.c. 376) it in Latin and noted, without any mention as to series, that it is related to *P. longicaulis* and *P. conifera*. In 1910 (in Bull. Soc. Bot. France, 57, Mém. 18: 26, 1910), in his keys, he included *P. dielsiana* in the series Coniferae together with *P. conifera*. Wilson did not give the exact locality where this number was collected, but in all probability it came from western Hupeh or Szechuan.

At an altitude of about 2135 meters in western China. Flowers yellow. Flowering in August. Known from the original collection only.

WESTERN CHINA: no precise locality, *Wilson* 4246 (UCLA).

This species is near *P. longicaulis*, especially in the acute mid-anterior lobe of the lower corolla-lip. However, it is readily distinguished by its much smaller pinnatisect leaves and smaller corollas that are yellow in color and bear a shorter beak.

Series 5. Coniferae

Coniferae Maxim. ex Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 207, 1890; Prain, in Ann. Bot. Gard. Calcutta, 3: 85, 1890.

Tall plants; stems branched above, the branches short, ascending; leaves 4-5-verticillate, short-pedicellate, rather small, pinnatisect, the segments more or less oblong, pinnatifid; inflorescences terminal, in compact racemes; bracts foliaceous; calyx turbinate, 5-dentate, the teeth deltoid to ovate, entire to dentate; corolla purple (?), the tube erect in the calyx, the galea produced into a beak, the lower lip shorter than the galea, the lateral lobes rounded, the mid-anterior smaller and more distad, cucullate at the apex; stamens inserted about ⅓ from the base of the tube, the filaments all glabrous.

This series consists of a single species, *P. conifera,* found in western Hupeh (Map 5). It is characterized by its branching habit, rather small short-petiolate pinnatisect leaves, beaked galea, rather short lower lip with the mid-anterior lobe angular-ovate and cucullate.

17. Pedicularis conifera Maximowicz

Pedicularis conifera Maxim. ex Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 206, 1890; Diels, in Bot. Jahrb., 29: 572, 1900; Limpricht, in Repert. Sp. Nov., 20: 243, 1924. The type, "Hupeh: South Patang (*A. Henry,* 7625!). Herb. Kew.," has not been seen.

Hupeh. No specimen seen.

This species, according to its description, has rather small flowers which are probably purple in color. It is characterized by the mid-anterior lobe of the lower corolla-lip being cucullate. In this character it is matched by *P. binaria.*

Series 6. Graciles

Graciles Prain in Ann. Bot. Gard. Calcutta, 3: 72, 1890.

Annual or perennial, tall, erect; stems slender, often much branched above; leaves 2-4-verticillate, oblong, pinnatifid, the lobes ovate, serrate; flowers racemose, laxly arranged; calyx tubular, inconspicuously to distinctly 5-dentate, the teeth equal, rounded to serrate; corolla purple, the tube longer than the calyx, the galea produced into a long slender beak, the lobes of the lower lip entire, glabrous; stamens inserted near the middle of the tube; filaments totally glabrous; capsules ovoid, erect, acuminate.

The series now contains *P. gracilis* Wall., *P. brunoniana* Wall. and *P. khasiana* (Hook. f.) Pennell, and is found throughout the Himalayas to Yunnan and Sikang in China. Only a variety of *P. gracilis* occurs in China (Map 5).

18. Pedicularis gracilis Wallich var. **sinensis** var. nov. Plate 16, fig. 15.

"*Pedicularis gracilis*" *sensu* Maxim., in Bull. Acad. St. Pétersb., 32: 552, 1888; in Mél. Biol., 12: 822, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 36: 209, 1890; Diels, in Bot. Jahrb., 29: 571, 1900; Bonati, in Notes Bot. Gard. Edinb., 5: 84, 1911; 7: 242, 1912; 8: 39, 1913; 15: 165, 1926; Limpricht, in Repert. Sp. Nov., 20: 259, 1924; 23: 338, 1927; Marquand & Shaw, in Journ. Linn. Soc. Bot., 48: 212, 1929; Hand.-Maz., Symb. Sin., 7: 867, 1926; *non* Wall.

"*Pedicularis gracilis* Wall. var. *typica*" *sensu* Limpricht, in Repert. Sp. Nov., 20: 259, 1924; *non* Prain.

"*Pedicularis gracilis* Wall. f. *stricta*" *sensu* Hand-Maz., Symb. Sin., 7: 867, 1936; *non* Prain.

A typo speciei differt plantā robustā; ramulis densis, 3-4-, interdum 5-6-verticillatis; calycis lobis distinctis, ovatis, serratis.

Type, at altitudes of 2750 to 3660 meters, eastern slopes of Likiang Snow Range, Yunnan Province, collected in flower, Aug. 22, 1922, by J. F. Rock, No. 6019; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotypes in the Gray Herbarium and the herbarium of the New York Botanical Garden.

Alpine meadows on mountain slopes, at altitudes of 2000 to 3600 meters, widely distributed in Yunnan and southeastern Sikang. Flowers purplish pink. Flowering in August and September.

SIKANG: Kanting District, *Fang* 3631 (GH, RBGE); Sichang District, *Yü* 1215 (GH), 1275 (GH); Hpimau, *Farrer* 1335 (RBGE).

YUNNAN: Kou toui, *Delavay* s.n. (UCLA); Yo-lin-chan, *Delavay* 6543 (ANSP, UCLA); Suen-oui, *Maire* 546 (UC); Ma-hong, *Maire* 3387 (ANSP, UCLA); Ho Kia Keou, *Maire* 3922 (ANSP, UCLA); Lou-pou, *Maire* 3928 (ANSP, UCLA); Tong-tschouan, *Maire* s.n. (USNH), 6374 (ANSP, UCLA), 6378 (ANSP, UCLA); Yun nan sen, *Ducloux* 914 (ANSP, UCLA), 5735 (GH, NYBG, USNH); Pan-tsin, Kiao-kia, *Ducloux* 983 (ANSP, UCLA); Likiang, *Schneider* 2327 (UCLA); eastern flank of Tali Range, *Forrest* 4496 (ANSP, UCLA); Tong Shan in the Yangtse bend, *Forrest* 10878 (UCLA); Mengtze, *Henry* 9710 (MBG, NYBG); eastern slopes of Likiang Snow Range, *Rock* 5849 (NYBG, USNH), 6019 (ANSP, GH, USNH); mountains of the Yangpi River drainage basin, near Tali, *Rock* 6208 (NYBG, USNH); Chio-kia District, Liang-shan, *Tsai* 52021 (AA); Liang-shan District, *Tsai* 51273 (AA); Shang-pa District, *Tsai* 54953 (AA); Lan-ping District, *Tsai* 56133 (AA); Wei-si District, *Tsai* 57923 (AA), 59558 (AA), 59860 (AA); Che-tse-lo, Pi-lo-shan, *Tsai* 58315 (AA); Muli, Wachin, near the Lamasery, *Yü* 14402 (AA); Likiang Snow Range, *Yü* 15552 (AA); Shunning, Hila, Wumulung, *Yü* 16740 (AA); no localities, *Forrest* 28909 (ANSP), *Tsai* 57598 (AA), 57674 (AA), 57753 (AA), *Yü* 14066 (AA).

Considerable confusion has existed in the interpretation of the species *P. gracilis* Wall. in India, hence the application of the name to Chinese plants is also not appropriate. Wallich, Numer. List Ind. Mus., 1829, originally listed three species, *P. gracilis*, *P. stricta*, and *P. brunoniana*, based on *Wallich* 413, 414, and 422 respectively. Bentham, in his Scroph. Indicae, 52, 1835, placed both *P. stricta* and *P. brunoniana* in the synonymy of *P. gracilis*. Prain, in Ann. Bot. Gard. Calcutta, 3: 137-140, 1890, treated three varieties under *P. gracilis:* var. *typica* with forms, *vera*, *stricta*, and *prostrata;* var. *macrocarpa* and var. *khasiana*. Apparently several different entities were involved in Prain's concept of the species. In the latest treatment of Indian Scrophulariaceae, Pennell, in Monogr. Acad. Nat. Sci. Phila., 5: 128-131, 1943, clarified the situation by reviving the name *P. brunoniana* Wall., placing in its synonymy *P. gracilis typica* f. *prostrata* Prain and *P. gracilis macrocarpa* Prain, while *P. gracilis khasiana* Hook. f. is made into a separate species, *P. khasiana* (Hook. f.) Pennell. Thus, what now remains in *P. gracilis* are two forms of Prain, *vera* and *stricta*.

Type specimens of both these two forms are available for study. The number *Wallich* 413, cited by Bentham, Scroph. Indicae, 52, 1835, was the type of *P. gracilis* Wall. and consequently that of f. *vera* Prain. An isotype is in the Bonati Herbarium and another in the herbarium of the Academy of Natural Sciences of Philadelphia. A duplicate of *Wallich* 414, the type of *P. stricta* Wall. and consequently that of *P. gracilis* f. *stricta* Prain, is also in the herbarium of the Academy of Natural Sciences of Philadelphia.

A comparison of the Chinese material with these Indian plants shows some differences, notably in the distinct calyx-teeth of the Chinese specimens, which are as long as, or longer than, wide and are distinctly serrate. In the Indian plants, the calyx-teeth are low and rounded. Moreover, the Chinese plants are much more robust, the branches mostly 4- or sometimes 5-6-verticillate and very erect; in general appearance they are closer to f. *stricta* than f. *vera* which has more slender and less straight branches. In f. *stricta*, the branches are only in 2s or 3s. As the Chinese plant resembles the Indian plants in general habit and in being an annual, and, furthermore, as the other floral characters remain similar between them, it is thought best to treat it as a variety of the species *P. gracilis* Wall.

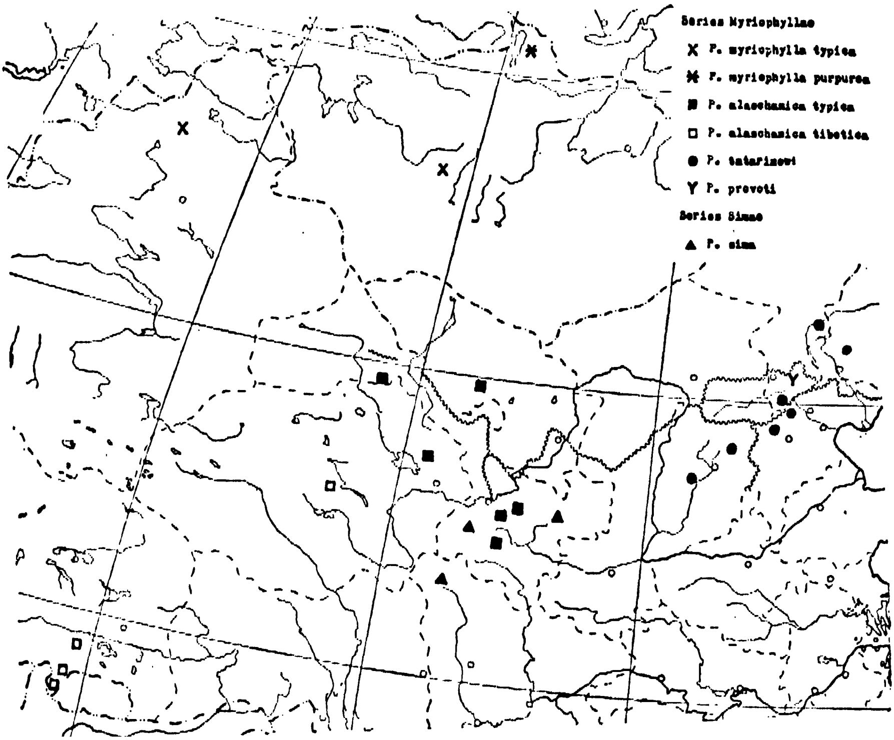
In the distinct calyx-teeth which are as long as, or longer than wide, and serrate, this variety resembles *P. brunoniana* Wall. But the latter is a perennial with long thickened roots and with more slender stem which is simple or only moderately branched.

Series 7. Myriophyllae

Myriophyllae Maxim., in Bull. Acad. St. Pétersb., 24: 58, 1878; 32: 76, 1888; in Mél. Biol., 10: 89, 1878; 12: 857, 1888.

Tall, erect plants, the stem branched at base, divaricate-ascending, usually simple above; leaves 4-verticillate, rarely opposite or 3-verticillate, pinnatisect, the segments distant, linear-lanceolate, pinnatifid; flowers numerous, in more or less interrupted racemes; bracts ovate, entire to serrate distally; calyx ovoid, more or less inflated, sometimes slightly cleft anteriorly, 5-dentate, the teeth equal to subequal, deltoid to ovate, entire to serrate; corolla purple, white, or yellow; the tube straight, the galea more or less straight proximally and bending distally, the apex produced into a beak; lower corolla-lip 3-lobed, the lobes rounded, the mid-anterior smaller and more distad; filaments glabrous to hairy.

Five or six species range from Alaska through the Aleutians to Kamchatka, Japan, Siberia, Mongolia, and northern China to the Tibetan Highland. This series occupies approximately the same region as the series Cheilanthifoliae (Map 6).



Map. 6.—Distribution of the series Myriophyllae and Simae.

Maximowicz in 1888 redefined his series of 1878 and this was further narrowed by Prain (in Ann. Bot. Gard., Calcutta, 3: 84, 1890), who was in turn followed by Limpricht (in Repert. Sp. Nov., 20: 241, 1924). But still two groups of species are clearly represented in this series. One, including *P. anas* and *P. curvituba*, has the corolla curved and deflexed in the calyx but again up-curved above the calyx at the junction of the tube and the galea. The other has the corolla more or less straight both within and without the calyx. So as to delimit the series naturally, the two species mentioned are herewith removed to form a new series Curvitubae. These two are undoubtedly phylogenetically related to the series Verticillatae, which has similarly curved corolla though without a beak. On the other hand, the series Myriophyllae, as now defined, is apparently linearly related to the series Cheilanthifoliae, but shows a tendency to have the galea prolonged into a beak.

Key to the Chinese Species

A. Calyx not cleft anteriorly; galea hardly bending distally, the beak short, not prominent, pointing outward. .... 19. *P. myriophylla*

AA. Calyx slightly cleft anteriorly; galea slightly or strongly bent distally, the beak long, prominent, pointing outward or downward.

B. Leaves with rachis and petiole strongly winged, opposite or 3-4-verticillate; calyx-teeth entire to obscurely serrate; beak more or less horizontal; anterior filaments pilose distally, posterior ones glabrous throughout. 20. *P. alaschanica*

BB. Leaves with rachis and petiole scarcely winged, all 4-verticillate; calyx-teeth distinctly serrate; beak horizontal or pointing downward; staminal filaments all hirsute, sometimes the posterior pair only sparsely so or glabrous.

C. Corolla purple; calyx-teeth mostly ovate and serrate; galea strongly bending distally; beak curved and pointing downward. 21. *P. tatarinowi*

CC. Corolla white; posterior calyx-tooth deltoid, the others foliaceous and serrate; galea hardly bending distally; beak horizontal, scarcely curved. 22. *P. provoti*

19. **Pedicularis myriophylla** Pallas

Key to the Varieties

A. Corolla rose, the tube short, about equal in length to or slightly exceeding the calyx. .... 19a. *P. m. typica*

AA. Corolla purple, the tube slightly longer, exceeding the calyx in length. 19b. *P. m. purpurea*

19a. **Pedicularis myriophylla** typica Plate 16, fig. 16.

Pedicularis myriophylla Pall., Reise, 3: 737, pl. 8, fig. 1A, 1776; Maxim., in Bull. Acad. St. Pétersb., 24: 61, 1878; 32: fig. 91, 1888; in Mél. Biol., 10: 93, 1878; 12: fig. 91, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 213, 1890; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; 20: 242, 1924. Pallas' type: "In paludibus alpinis Dauuriae ad Kirkun riuum et in summis Iugo Altaici, Montisque *Sinaia Sopka* dicti legit Studiosus," has not been seen.

In Siberia, Sinkiang and Mongolia. Flowers rose.

DZUNGARIA: *Politow* s.n. (ANSP).

MONGOLIA: central Mongolia, *Ikonnikov-Galitzky* 4225 (UC, NYBG).

19b. **Pedicularis myriophylla purpurea** Bunge

Pedicularis myriophylla β purpurea Bunge, in Walp., Repert., 3: 410, 1844-45; Maxim., in Bull. Acad. St. Pétersb., 24: 61, 1878; in Mél. Biol., 10: 93, 1878; Limpricht, in Repert. Sp. Nov., 20: 242, 1924. With reference to Mem. Acad. St. Petersburg, 2: 567, 1835 (Florae Altaicae Supplementum) where Bunge says, "Varietatem purpuream (*P. rupestris* Turcz.) praeter colorem nulla re diversam observavimus." Walpers, in forming *β purpurea* Bunge, cited no specimens, those seemingly associated with it pertaining actually to *P. myriophylla*.

MONGOLIA: Lake Kossogol, *Turczaninow* s.n. (ANSP, B).

HOPEI: Hsiaewutaishan, *Kung* 997 (RBGE).

20. **Pedicularis alaschanica** Maximowicz

Key to the Varieties

A. Calyx-teeth obscurely serrate to subentire; beak longer, curved. .. 20a. *P. a. typica*

AA. Calyx-teeth strictly entire; break shorter, less curved and more horizontal. 20b. *P. a. tibetica*

20a. Pedicularis alaschanica typica Prain Plate 16, fig. 17.

Pedicularis alaschanica Maxim., in Bull. Acad. St. Pétersb., 24: 59, 1878; 32: 578, fig. 86, 1888; in Mél. Biol., 10: 91, 1878; 12: 860, fig. 86, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 36: 204, 1890; Diels, in Futterer, Durch Asiens, 3: 20, 1911; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; in Repert. Sp. Nov., 20: 242, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 32, 1933; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 208, 1934; Walker, in Contr. U. S. Nat. Herb., 28: 659, 1941. Maximowicz based his species on a number of collections: "In *Mongoliae* australis jugo Alaschan parte media, ad rupes rara, in *Chinae* prov. *Kansu*, deserto collino elato inter jugum boreale finitimum et aliud illi parallelum extenso, nev non ibidem ad latera montium, rara (Przewalski)." In the Bonati Herbarium, there is a sheet with two specimens bearing two labels. These are from the Herb. Petrop. and both in the handwriting of Maximowicz. One of the labels reads: "*Pedicularis alaschanica* Maxim. Prov. Kansu, Terra Tangutorum. In deserto. 21. VI./3 VII. 1872. Legit N. M. Przewalski. Det. Maximowicz." This is evidently a syntype. The other label reads: "*Pedicularis alaschanica* Maxim. Kansu orientalis, circa monasterium Dschoni. 30 V-6 VI 1885, Legit G. N. Potanin." This one together with another of Przewalski in 1879, "Mongolia occid., alpes Nan-shan," are evidently among the ones Maximowicz cited and illustrated in 1888. Maximowicz described the filaments as glabrous, but his illustration does not depict the filaments. The type specimen, mentioned above, shows the anterior filaments hirsute distally.

Pedicularis alaschanica var. *typica* Prain, in Ann. Bot. Gard. Calcutta, 3: 164, 1890; Limpricht, in Repert. Sp. Nov., 20: 242, 1924.

Alpine meadows and sandy rocky slopes of river valleys at altitudes of 1750 to 3250 meters, in western Mongolia, Kansu, and Chinghai. Flowers yellow. Flowering from June to September.

KANSU: Tangut Region, *Przewalski* s.n. (UCLA); eastern Kansu, near Choni monastery, *Potanin* s.n. (UCLA); Nan Shan, *Przewalski* s.n. (UCLA); T'ao River Basin, Choni, *Rock* 12568 (ANSP, GH, NYBG, USNH); T'ao River Basin, between Choni and Kwadjaku ferry, *Rock* 12459 (ANSP, GH); Li-chen, Ping Fan, *Ching* 365 (USNH); Ho Lan Shan, *Ching* 1081 (USNH).

CHINGHAI: Kokonor Region, *Rock* 13374 (ANSP, GH, NYBG).

A very striking plant, with glaucous linear-lanceolately dissected leaves and much dilated bracts. In its general appearance, it resembles somewhat *P. dichotoma* but the leaves are 2-3- or 4-verticillate and the stems do not branch above; in *P. dichotoma*, the leaves are strictly opposite, and the stems branch above. In spite of the similarity in the leaves, the two species differ from each other in the details of the flowers and are not supposed to be closely related.

20b. Pedicularis alaschanica tibetica Maximowicz

Pedicularis alaschanica var. *tibetica* Maxim., in Bull. Acad. St. Pétersb., 32: 578, 1888; in Mél. Biol., 12: 860, 1888; Prain, in Ann. Bot. Gard. Calcutta, 3: 164, 1890; Limpricht, in Repert. Sp. Nov., 20: 243, 1924. Maximowicz' types were from Tibet: "Tibet boreali orientali: valle fl. Assakgol, cum specie praecedente (Przewalski, '84); Himalaya: Chumbi et Phari (hb. Calcutta)."

TIBET: Gtyantse Hills, *H. M. Stewart* s.n. (Calcutta); Golishi, *Chapman* 793 (GH).

This variety, found only in Tibet and Chinghai, is distinguished from the typical form of the species by the calyx-teeth being strictly entire, and the beak being less bent and shorter.

21. Pedicularis tatarinowi Maximowicz Plate 16, fig. 18.

Pedicularis tatarinowi Maxim., in Bull. Acad. St. Pétersb., 24: 60, 1878; 32: 858, fig. 83, 1888; in Mél. Biol., 10: 92, 1877; 12: 858, fig. 83, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 217, 1890; Limpricht, in Repert. Sp. Nov., 20: 241, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 221, 1934. The type, "China boreali, ab urbe Pekino occidentem versus, circa She-Che (Jehol) legit Dr. Tatarinow," has not been seen. The description and illustration are distinctive.

Pedicularis borodowskii Palabin, in Act. Hort. Petrop., 14: 134, 1895; Limpricht, in Repert. Sp. Nov., 20: 242, 1924. The type "Mongolia orientalis, circa opp. Dolonnor, in collibus arenosis copiose; initio Augusti florens. [L. I. Borodowsky in 1891]" has not been seen. Dolon-nor is in the eastern part of Chahar Province, close to the border of Jehol Province. According to the descriptions, the only difference that can be made out between this species and *P. tatarinowi* is that in *P. tatarinowi* the corolla-tube is scarcely longer than the calyx, while in *P. borodowski* it is almost twice as long. But in the specimens cited below, the corolla in younger flowers has the tube about as long as the calyx while in old flowers it may become almost twice as long as the calyx. Palabin described the corolla as yellowish in the dry state but with violet veins, thus seeming to indicate that the flowers were originally violet. He also observed tuberculate hairs inside the corolla-tube and the galea; such hairs, although not described by Maximowicz, have been noticed in the specimens cited below. It seems that Palabin's plant is in all respects conspecific with *P. tatarinowi*.

Alpine regions at altitudes of about 2000 meters, in Jehol, Chahar, northern Hopei, and northern Shansi. Flowers pink to purple. Flowering in July and August.

HOPEI: Hsiao Wutaishan, *no collector's name* (UCLA), *C. F. Li* 11038 (NYBG); Yang Chia Ping, *Y. Liu* (NYBG, UC); Po-hua-shan, *T. F. King* 476 (UC); Ling Shan, *J. C. Liu* 1479 (UC).

SHANSI: Mt. Wutai, *T. Tang* 1179 (NYBG); Chiao-chen District, *K. Ling* 9546 (USNH).

This species is apparently related to *P. myriophylla* Pall. but can be distinguished by its larger flowers, its calyces slightly cleft anteriorly, its longer beaks strongly bending downward, and its hairy filaments. Maximowicz originally described the filaments as wholly pilose. The anterior filaments prove to be always densely pilose, while the posterior ones are only sparsely so, or sometimes may be glabrous.

22. Pedicularis provoti Franchet

Pedicularis provoti Franch., in Morot, Journ. de Bot., 4: 318, 1890; Limpricht, in Repert. Sp. Nov., 20: 242, 1924. The type, "In montibus ad occidentem urbis Suen-hoa-fou circiter ad leucas 15 sitis; fl. jun. 1888 (M. Provôt)," has not been seen. The type locality is Hsüan-hwa, in the southern part of Chahar Province, and a little south of Kalgan. Franchet considered his species as very near *P. tatarinowi* Maxim., of which he had seen no specimen.

Chahar Province. Flowers white. Flowering in June. Known from the original collection only. No specimen seen.

This species, according to its original description, is very near *P. tatarinowi*, but it differs in corolla and calyx. Franchet observed tuberculate hairs on the inside of the tube and the sides of the galea, such as are also found in *P. tatarinowi*. The calyx of *P. tatarinowi* is very slightly cleft anteriorly, a matter not mentioned by Franchet.

Series 8. Simae

Simae Prain, in Ann. Bot. Gard. Calcutta, 3: 97, 1890.

Erect, stem simple or branched at base, pubescent; leaves opposite or 3-verticillate, petiolate, oblong, pinnatifid, the segments ovate, serrate; flowers 3-verticillate, spicate, the lowers distant; calyx cylindrical, 5-dentate, the teeth unequal, one of them deltoid and entire, the others ovate and serrate; corolla-tube erect; galea longer than the lower lip, the apex forming a very short obtuse beak; lobes of the lower lip all rounded, ciliate at margins, the mid-anterior lobe much smaller; filaments glabrous.

Pedicularis sima was originally included by Maximowicz in 1881 in the series Myriophyllae, but in 1888 was transferred by him to the Verticillatae. Prain (l.c.) erected for it the series Simae. (Map 6.)

23. **Pedicularis sima** Maximowicz

Pedicularis sima Maxim., in Bull. Acad. St. Pétersb., 27: 514, 1881; 32: 592, fig. 107, 1888; in Mél. Biol., 11: 284, 1881; 12: 880, fig. 107, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 216, 1890; Limpricht, in Repert. Sp. Nov., 20: 211, 1924. Maximowicz's type, "Kansu occidentali in pratis alte alpinis (Przewalski, 1880)," has not been seen.

Eastern and western Kansu and northern Szechuan. Flowers rose. No specimen seen.

Series 9. Pectinatae

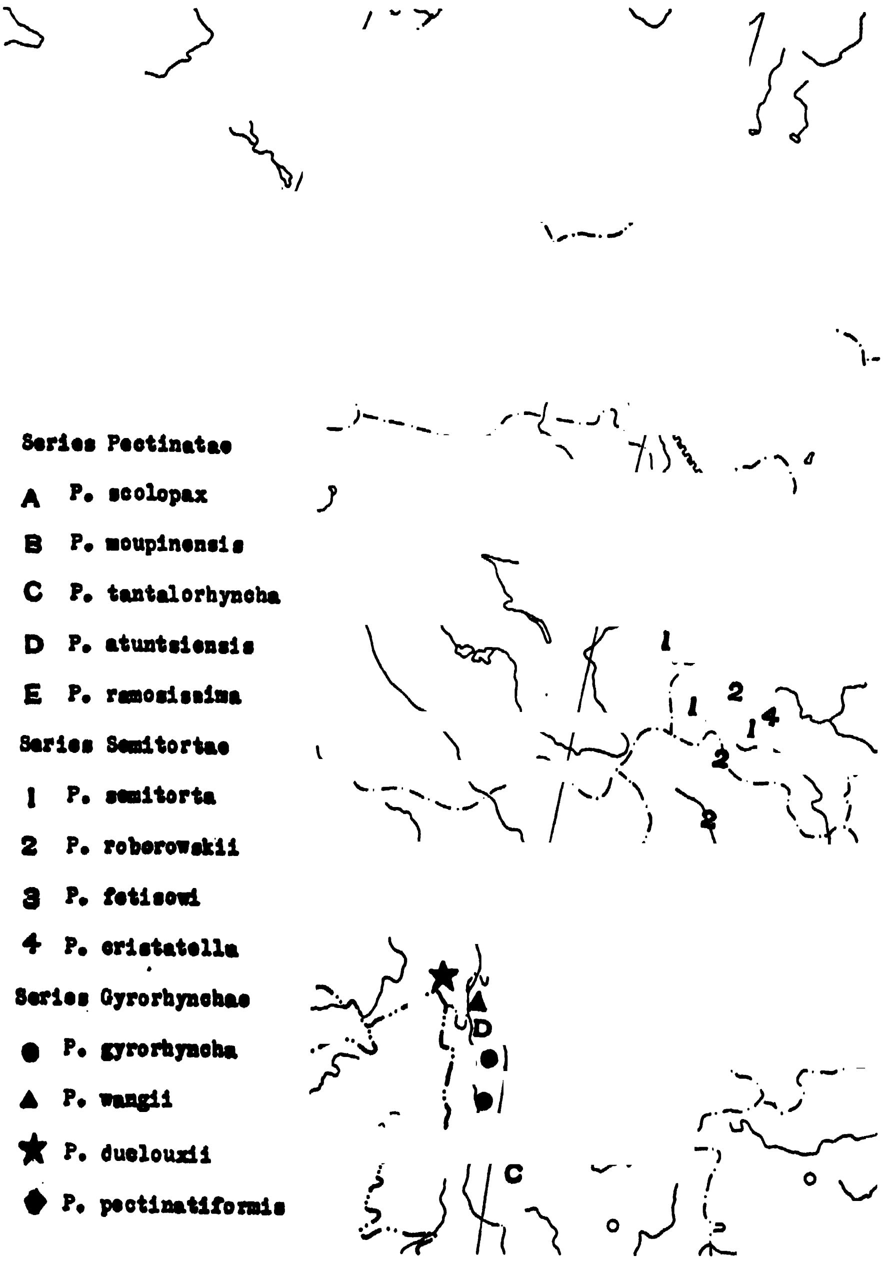
Pectinatae Prain, in Ann. Bot. Gard. Calcutta, 3: 71, 1890, p.p.

Usually tall erect plants; stems sometimes branching at base, simple or short-branched above; leaves 3-4-verticillate, sometimes opposite and verticillate, petiolate, ovate-oblong to oblong-lanceolate, deeply pinnatifid to pinnatisect, the lobes oblong, sometimes linear; inflorescences long-spicate, compact or interrupted below; bracts ovate to oblong, sometimes dilated proximally, usually serrate distally; calyx slightly cleft anteriorly or not, 5-dentate, the teeth equal to unequal, entire to dentate or serrate; corolla purple or yellow, the beak long, slender, more or less straight and horizontal, the lower lip with ciliate or glabrous margins; staminal filaments glabrous or hairy.

About 6 species, from the eastern Himalayas to northern Yunnan, Sikang, and Chinghai (Map 7).

The series Pectinatae as here defined consists of species that have a more or less straight and horizontal beak. In this character, this series can be distinguished from the related series Semitortae and Gyrorrhynchae, which both have the beak strongly bending or coiling into a circle or semicircle. Also the species of this series have the upper bracts ovate to oblong, usually dilated proximally and serrate distally, in contrast with those of the series Semitortae, which are usually 3-5-fid.

In addition to the species given below, Marquand (in Journ. Linn. Soc. Bot., 48: 213, 1929) recorded *Pedicularis pectinata* Wall., List n. 420, 1829,



Map 7.—Distribution of the series Pectinatae, Semitortae, and Gyrorrhynchae.

ex Benth., Scroph. Indicae, 52, 1835, from western Sikang. This is one of the characteristic and dominant species of the western Himalayas. For a full account of the species and its subspecies, see Pennell, in Monogr. Acad. Nat. Sci. Phila., 5: 132-135, 1943.

Key to the Chinese Species

A. Leaves deeply pinnatifid; corolla yellow throughout, the margin of the lower lip glabrous. .... 24. *P. scolopax*

AA. Leaves pinnatisect; corolla purple throughout, the margin of the lower lip ciliate.

  B. Calyx cleft anteriorly, the teeth deltoid, entire; 2 of the staminal filaments hairy. .... 25. *P. moupinensis*

  BB. Calyx cleft or not cleft anteriorly, the teeth equal to unequal, all flabellate or 4 of them serrate and the posterior entire; all staminal filaments glabrous.

    C. Calyx cleft anteriorly. .... 26. *P. tantalorhyncha*

    CC. Calyx not cleft anteriorly.

      D. Stem simple; calyx slightly reticulate, the teeth unequal, the posterior one entire, the others lanceolate and serrate; corolla not cristate, the median lobe of the lower lip not cucullate. 27. *P. atuntsiensis*

      DD. Stem branched; calyx not reticulate, the teeth unequal, flabellate; corolla cristate, the median lobe of the lower lip cucullate. 28. *P. ramosissima*

24. Pedicularis scolopax Maximowicz Plate 16, fig. 19.

Pedicularis scolopax Maxim., in Bull. Acad. St. Pétersb., 27: 513, 1881; 32: 547, fig. 30, 1888; in Mél. Biol., 11: 282, 1881; 12: 814, fig. 30, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 216, 1890; Limpricht, in Repert. Sp. Nov., 20: 262, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933. Maximowicz's type, "*Kansu* occidentali alpina, ad summum fl. Hoangho (Przewalski, 1880, spec. 1)," has not been seen. The description and illustration are distinctive.

In alpine regions, at altitudes of 3500 to 4000 meters, in northeastern Chinghai and western Kansu. Flowers yellow. Flowering in June.

CHINGHAI: Radja and Yellow River Gorges, Deyang valley east of Radja, *Rock* 14132 (ANSP, GH, NYBG).

In both vegetative and floral structures, this species resembles so much *P. alaschanica*, that undoubtedly the 2 species are closely related. They are very similar in the shape and arrangement of the leaves, and in the prominent elevated veins of the calyx, but in *P. alaschanica* the calyx is slightly cleft anteriorly. Both have yellow flowers but the beak of *P. scolopax* is much longer. The bracts of *P. alaschanica* are profoundly dilated at the base.

25. Pedicularis moupinensis Franchet

Pedicularis moupinensis Franch., in Nouv. Arch. Mus. Paris II, 10: 67, 1888 (Pl. David.); Maxim., in Bull. Acad. St. Pétersb., 32: 551, fig. 36, 1888; in Mél. Biol., 12: 820, fig. 36, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 213, 1890; Diels, in Bot. Jahrb., 29: 571, 1901; Limpricht, in Repert. Sp. Nov., 20: 258, 1924. Franchet's type was from Szechuan: "Moupine, in pratis regionis altissimae. [David] Fl. Aug. 1869." It has not been seen.

In western Szechuan and eastern Kansu (ex Maxim. l.c.). No specimen seen.

Prain (in Ann. Bot. Gard. Calcutta, 3: 73, 1890) included this species in the Flexuosae, which is primarily a series of the eastern Himalayan region, but it differs notably from his other species of that series in its 4-verticillate leaves, those all having opposite leaves only. *Pedicularis moupinensis* seems more appropriately included in the series Pectinatae.

26. Pedicularis tantalorhyncha Franchet Plate 16, fig. 20.

Pedicularis tantalorhyncha Franch. ex Bonati, in Bull. Soc. Bot. France, 56: 466, 1909; Bonati, in Notes Bot. Gard. Edinb., 5: 84, 1911; 7: 242, 1912; Limpricht, in Repert. Sp. Nov., 20: 262, 1924. The type was from northwestern Yunnan: "Mont Tsang-chan, au-dessus de Tali (*Delavay*, sans n°)." Two isotypes with nine specimens are in the Bonati Herbarium.

Shady situations and valleys, at altitudes of about 3050 to 4000 meters, in northwestern Yunnan. Flower rose. Flowering in June and July.

YUNNAN: Tsang Shan above Tali, *Delavay* s.n. (ANSP, UCLA); eastern flank of the Tali Range, *Forrest* 4497 (ANSP, UCLA).

This species of Franchet was first published by Bonati. The species is characterized by its rectangularly bending and slightly cristate galea. The beak is either straight or slightly bending distally. Bonati described the lower lip of the corolla as glabrous, but in the type specimens examined, the lobes of the lower lip are minutely ciliate as in the related species.

27. Pedicularis atuntsiensis Bonati Text-figure 1.

Pedicularis atuntsiensis Bonati, in Notes Bot. Gard. Edinb., 8: 135, 1913; Limpricht, in Repert. Sp. Nov., 20: 264, 1924. The type, "N. W. Yunnan, at Atuntsi. Alt. 14,000 ft. July 1911. F. Kingdon Ward. No. 115," is in the herbarium of the Royal Botanic Garden, Edinburgh. A photograph is in the herbarium of the Academy of Natural Sciences of Philadelphia.

At an altitude of about 4270 meters in northwestern Yunnan. Flowers purple. Flowering in July. Known from the original collection only.

YUNNAN: Atuntsi, *Ward* 115 (RBGE).

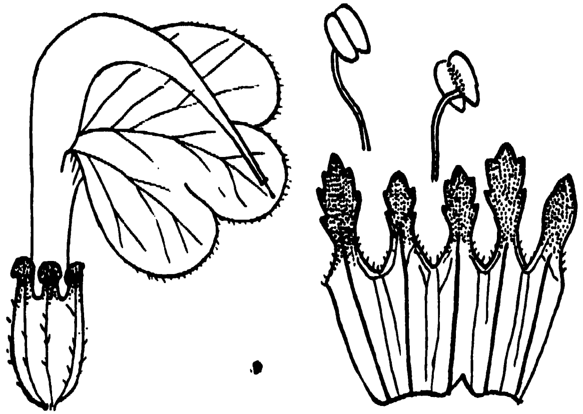
According to Bonati: "This new species comes nearest to *P. ramosissima* Bonati, but is distinguished at once by the simple stems, by the small size, by the more elongated corolla tube, by the longer beak and longer lip, etc."

28. Pedicularis ramosissima Bonati

Pedicularis ramosissima Bonati, in Bull. Soc. Bot. France, 55: 246, 1908; Limpricht, in Repert. Sp. Nov., 20: 263, 1924. The type, "Yargong (R. P. Soulié) n° 5283, août 1904 (Herb. Mus. Paris)," has not been seen.

In Sikang. Flowers purple. Flowering in August. Known from the original collection only. No specimen seen.

This species is characterized by its branching habit, its cristate galea, and the cucullate median lobe of the lower corolla-lip.



Text-figure 1.—*Pedicularis atuntsiensis* Bonati.

Series 10. Semitortae

Semitortae Prain, in Ann. Bot. Gard., Calcutta, 3: 71, 1890, p.p.

Tall erect plants, the stems usually branched at the base only; leaves usually 4-verticillate, pinnatisect to deeply pinnatifid, the lobes pinnatifid to serrate; inflorescences long-spicate, interrupted; lower bracts foliaceous, upper bracts slightly enlarged at base, usually 3-5-fid, rarely not lobed, the segments entire or pinnatifid; calyx slightly cleft or not cleft anteriorly, the teeth equal to unequal, entire to serrate; corolla yellow or purple, the tube straight, the galea bending distally, with or without deltoid teeth on the lower margins, the beak long, strongly bent near the tip or coiling in a circle, sometimes twisting laterally, the lower lips glabrous along the margins, the median lobe smaller, not cucullate; filaments glabrous to hairy.

About 5 species from Siberian Turkestan, Sinkiang, and Chinghai to western Kansu (Map 7).

This series as here redefined eliminates *P. scolopax* which is replaced by *P. fetisowi.* Prain originally stressed the character of 3-5-lobed upper bracts. While *P. fetisowi* has the upper bracts ovate and not 3-lobed, it is both geographically and structurally close to the other species of the series. The species of this series resemble those of the series Gyrorrhynchae, which occur in the south in Sikang and Yunnan only, in the distinctly bending or coiling beak. However, in addition to the bracts, species of Semitortae can be distinguished from those of Gyrorrhynchae in that the lower corolla-lip has glabrous margins and the median lobe of the lower lip is not cucullate.

One species, *Pedicularis tianschanica* Ruprecht, occurring in western Tien Shan close to the Chinese border, is also included in the key.

Key to the Species

A. Corolla yellow, the galea not cristate.
  B. Leaves pinnatisect; upper bracts 3-lobed; calyx cleft anteriorly, the teeth subequal, entire to subentire; staminal filaments all glabrous or 2 of them hairy.
    C. Beak very long, twisted laterally into a circle; 2 of the staminal filaments hairy. .... 29. *P. semitorta*
    CC. Beak lightly bent above, coiled at the tip, not twisting laterally; all staminal filaments glabrous. .... 30. *P. roborowskii*
  BB. Leaves pinnatifid; upper bracts 3-5-lobed; calyx not cleft anteriorly, the teeth unequal, the posterior one entire, the others serrate; all staminal filaments hairy. .... [*P. tianschanica*] [14]
AA. Corolla purple, the galea cristate.
  B. Leaves pinnatifid; upper bracts ovate, acute; calyx slightly cleft anteriorly, the teeth subentire, the posterior one usually smaller; beak coiled into a semicircle; staminal filaments all glabrous. .... 31. *P. fetisowi*
  BB. Leaves pinnatisect; upper bracts 3-lobed; calyx not cleft anteriorly, the teeth entire, equal to subequal; beak bending downward; 2 of the staminal filaments hairy. .... 32. *P. cristatella*

29. Pedicularis semitorta Maximowicz Plate 16, fig. 21.

Pedicularis semitorta Maxim., in Bull. Acad. St. Pétersb., 32: 546, fig. 28, 1888; in Mél. Biol., 12: 813, fig. 28, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 216, 1890; Limpricht, in Repert. Sp. Nov., 20: 262, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 219, 1934. Maximowicz's types were from various localities in Kansu: "Prov. *Kansu* parte occidentali: prope monasterium Kadiger, parte orientali: valle fl. Tao-che ad monast. Dshoni, nec non in monte Yali-ssan non procul a pago Katapu (Potanin, 1885)." A duplicate (isotype), from the first mentioned locality, is in the Bonati Herbarium; portions of this will pass to the University of California at Los Angeles, and to the Academy of Natural Sciences of Philadelphia.

Alpine meadows, at altitudes of 2500 to 3500 meters, in southwestern Kansu and eastern Chinghai. Flowers yellow. Flowering in June and July.

KANSU: T'ao River valley, *Potanin* s.n. (ANSP, UCLA); Choni, along the T'ao River, *Rock* 12255 (GH), 12268 (ANSP, GH); Lien-hwa-shan, *Rock* 12696 (ANSP, USNH); T'ao River basin, beyond Poyu, *Rock* 12795 (ANSP, GH, NYBG).

CHINGHAI: Radja and Yellow River Gorges, Deyang valley, east of Radja, *Rock* 14127 (ANSP, GH); Radja, *Rock* 14215 (ANSP, GH); between Hetso and Chiu-ssu, between Labrang and the Yellow River, *Rock* 14548 (ANSP, GH).

This species is strongly characterized by the finely dissected leaves which are mostly 4-verticillate, the anteriorly cleft calyx with elongate, entire to subentire teeth, and the yellow corolla with two broad teeth on the lower side of the galea, and a long beak twisting laterally in a spiral with the tip pointing upward; the flower is thus bilaterally strongly asymmetrical.

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[14] *Pedicularis tianschanica* Ruprecht, in Mem. Acad. St. Pétersb., VII, 14 (4): 63, 1869; Maxim., in Bull. Acad. St. Pétersb., 27: 511, 1881; in Mél. Biol., 11: 280, 1881; Limpricht, in Repert. Sp. Nov., 20: 262, 1924. The type, "22 Jul. fl." from western Tien Shan, was collected by Osten-Sacken. It has not been seen. Flowers yellow. Flowering in July. No specimen seen. Distribution: In Siberian Turkestan, in western Tien Shan, close to the Sinkiang border.

30. Pedicularis roborowskii Maximowicz

Pedicularis roborowskii Maxim., in Bull. Acad. St. Pétersb., 27: 5, 1881; 32: 546, fig. 29, 1888; in Mél. Biol., 11: 281, 1881; 12: 814, fig. 29, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 215, 1890; Limpricht, in Repert. Sp. Nov., 20: 262, 1924; Hand.-Maz., Symb. Sin., 7: 870, 1936. The type, "In *Kansu* occidentali alte alpina (Przewalski, 1880)," has not been seen.

In alpine regions in western Kansu and northern Szechuan. No specimen seen.

31. Pedicularis fetisowi Regel

Pedicularis fetisowi Regel, in Act. Hort. Pétrop., 6: 349, 1879; Maxim., in Bull. Acad. St. Pétersb., 27: 512, 1881; in Mél. Biol., 11: 281, 1881; Limpricht, in Repert. Sp. Nov., 20: 264, 1924. The type, "In valle fluvii Juldus leg. Fetisow," has not been seen. This species was also cited by Maximowicz in the key in his work of 1888, but was not illustrated.

In Yuldus Valley, eastern Tien Shan, Sinkiang. Known from the original collection only. No specimen seen.

This species is characterized by its cristate galea with the beak incurved in a semicircle. The calyx is slightly cleft and has 5 subentire teeth with the posterior one smaller than the others. The staminal filaments are all glabrous.

32. Pedicularis cristatella Pennell & Li, nom. nov. Plate 16, fig. 22.

Pedicularis cristata Maxim., in Bull. Acad. St. Pétersb., 32: 547, fig. 31, 1888; in Mél. Biol., 12: 814, fig. 31, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 207, 1890; Limpricht, in Repert. Sp. Nov., 20: 262, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933; Hand.-Maz., Symb. Sin., 7: 870, 1936; *non* Vitm. 1789. Maximowicz's type, "Sze-tschuan parte boreali: prope oppidum Ssun-pan (Potanin)," has not been seen. The species is very distinct and readily recognized by the original description and illustration.

On cliffs and meadows of valleys, at altitudes of 2580 to 2750 meters, in northern Szechuan and southwestern Kansu. Flowers purplish red. Flowering in July.

KANSU: T'ao River basin, Toyuku, *Rock* 12828 (ANSP, GH); T'ao River basin, *Rock* 12879 (ANSP, GH, NYBG); T'ao River basin, Toyuku near Choni, *Rock* 12910 (ANSP, GH).

A species strongly characterized by the membranaceous calyx with prominent nerves and entire teeth and the strongly cristate corolla which is purplish red. In the dried state, the upper part of the galea and the beak are much darker than the rest of the flower.

Series 11. Gyrorrhynchae

Gyrorrhynchae Prain, in Ann. Bot. Gard. Calcutta, 3: 70, 1890.

Tall, erect; stem simple or branching above, villose; leaves opposite to 3-4-verticillate, subsessile to short-petiolate, oblong-lanceolate, deeply pinnatifid to pinnatisect, the lobes pinnatifid; inflorescences spicate, interrupted; lower bracts foliaceous, upper bracts usually enlarged proximally, dentate to pinnatifid distally; calyx not cleft anteriorly, 5-dentate, the teeth unequal, one of them smaller, entire to serrate; corolla purple, or yellow proximally and purple distally, the tube erect, the galea bending above, sometimes twisted, the beak long, coiled into a semicircle, the lower lip ciliate on the margins, the median lobe smaller and cucullate; staminal filaments glabrous to hairy.

Four species in northwestern Yunnan and Sikang (Map 7).

Prain established the series Gyrorrhynchae to accommodate the species *P. gyrorrhyncha*. He placed this series along with two others, Integrifoliae and Franchetianae, as forming the subsection " Oppositifoliae " of his § Siphonanthae, to be separated from § Orthorrhynchae where the series Pectinatae and Semitortae are placed. Clearly the affinity of the species *P. gyrorrhyncha* is with the species of these two latter series and not with the other series as in Prain's system. Prain's arrangement of these groups, being based only on superficial unrelated characters, is quite unsatisfactory.

The series Gyrorrhynchae is closely related to the series Pectinatae. It may be distinguished from the latter by its longer and much coiled beak which often forms a semicircle. In Pectinatae, the beak is more or less straight and horizontal. In the bending and coiling beak, the series Gyrorrhynchae is similar to the series Semitortae. However, in addition to the bracts of the former being not 3-5-lobed, it can be distinguished from the latter by the ciliate-margined lower corolla-lip and by the cucullate median lobe.

Key to the Species

A. Calyx-teeth unequal, one entire and the others much broader, obscurely to distinctly serrate; 2, or all 4, staminal filaments hairy.
    B. All staminal filaments hairy; lateral calyx-teeth distinctly or obscurely serrate.
        C. Flowers larger, the corolla about 1.7 cm. long; lateral calyx-teeth broad and short, distinctly serrate; beak extending horizontally for half of its length. .... 33. *P. gyrorrhyncha*
        CC. Flowers smaller, the corolla about 1.2 cm. long; lateral calyx-teeth linear and obscurely serrate; beak bending downward abruptly near its base. .... 34. *P. wangii*
    BB. Two of the staminal filaments hairy; lateral calyx-teeth obscurely serrate. 35. *P. duclouxii*
AA. Calyx-teeth subequal, linear and entire; all staminal filaments glabrous. 36. *P. pectinatiformis*

33. Pedicularis gyrorrhyncha Franchet Plate 16, fig. 23.

Pedicularis gyrorrhyncha Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 545, fig. 24, 1888; in Mél. Biol., 12: 812, fig. 24, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 209, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 83, 1911; 7: 198. 1912; 15: 168, 1926; Limpricht, in Repert. Sp. Nov., 20: 264, 1924; 23: 337, 1927; Hand.-Maz., Symb. Sin., 7: 871, 1936. The type, "prov. Yunnan, ad fauces Koua-la-po (Delavay! in hb. Paris)," has not been seen.

Open situations among scrubs or open marshy pastures on the margins of thickets, at altitudes of 2750 to 3300 meters, in northwestern Yunnan. Flowers yellow with rose beak. Flowering in July and August.

YUNNAN: no localities, *Forrest* s.n. (UCLA), *Tsai* 57666 (AA), *Yü* 9518 (AA); Likiang, Yulung Shan, *Handel-Mazzetti* 4354 (USNH); Likiang Range, *Forrest* 2944 (UCLA); Mekong-Yangtze divide, Kari pass, *Forrest* 12974 (ANSP, UCLA); Chi Shan, east to Tali Range, *Forrest* 13462 (ANSP, UCLA); between Likiang, Youngning and Youngpei, en route to Muli, *Rock* 5309 (ANSP, UC, USNH); Wei-si District, Yeh-chih, *C. W. Wang* 68193 (AA), 68694 (AA); S.E. Chungtien, between Pei-lun-shan and Anangu, *Feng* 2022 (AA).

34. **Pedicularis wangii** sp. nov. Plate 17, fig. 24.

Annua, ad 40 cm. alta, caulibus erectis, gracilibus, glabratis vel superne leviter puberulis, ad basim ramosis, superne parce breviter ramosis; foliis 3-verticillatis, membranaceis, utrinque glabris, breviter vel longe petiolatis (petiolis 0.5-2.5 cm. longis, alatis, ad 1.5 mm. latis) ovato-oblongis, ad 4.5 cm. longis et 2.5 cm. latis, profundissime pinnatifidis vel pinnatisectis, rhachidibus bene alatis, 2-5 mm. latis, segmentis utrinsecus 4-6, valde distantibus, oblongis vel oblongo-lanceolatis, ad 1.2 cm. longis, 6 mm. latis, profunde pinnatifidis vel dentatis; inflorescentiis terminalibus interrupte spicatis; bracteis inferioribus foliaceis, superioribus basi dilatatis integris superne oblongis profunde pinnatifidis, calyce duplo vel triplo longioribus; pedicellis 1-2 mm. longis; calyce cupuliformi, calycis tubo 4 mm. longo, membranaceo, glabro, 10-costato, haud reticulato, dentibus 5, inaequalibus, uno deltoideo, nano, caeteris linearibus, integris vel obscure serratis, margine ciliatis, leviter reticulatis; corollā luteā galeā nigrā exceptā, 1.2 cm. longā: tubo erecto, calycem aequante; galeā rectā, apice in rostrum productā, rostro 5-6 mm. longo, ad basim abrupte curvato, deflexo; staminibus ad medium tubi insertis, filamentis omnino hirsutis; stylo incluso; capsulis ignotis.

Type, on grassy slopes, at an altitude of 3600 meters, Atuntze, Huann-fu-ping, in northwestern Yunnan, collected in flower, Aug. 1935, by C. W. Wang, No. 68960; holotype in the herbarium of the Arnold Arboretum. Only collection seen. Flowers yellow with dark beak.

This species closely resembles *Pedicularis gyrorrhyncha* in its general appearance, and is undoubtedly a relative.

35. **Pedicularis duclouxii** Bonati Plate 17, fig. 25.

Pedicularis duclouxii Bonati, in Bull. Soc. Bot. France, 55: 245, 1908; Limpricht, in Repert. Sp. Nov., 20: 263, 1924; Hand.-Maz., Symb. Sin., 7: 870, 1936. The type, "Yargong, dans les forêts (*R. P. Soulié*) n° 5197, 1904 (Herb. Mus. Paris)," from Sikang, has not been seen. The following specimens match well the original description.

Pedicularis muliensis Hand.-Maz., Symb. Sin., 7: 869, pl. 15, fig. 11, 1936. The type is from "S[zechuan]: Steinige Gebüsche der Hg. St. an der Nordseite des Passes Döko sw von Muli, Tonschiefer, 4200-4300 m, 4. VIII. 1915 ([Handel-Mazzetti] 7419)." A duplicate in the Edinburgh Herbarium has been seen.

In forests at an altitude of about 3400-4300 meters, in Sikang. Flowers yellow with dark beak. Flowering in August and September.

SIKANG: Muli, *Handel-Mazzetti* 7419 (RBGE); Tsa-wa-rung, Sacred Mt. Kar-war-kar-boo, *C. W. Wang* 66248 (AA).

This species is characterized by the sigmoid beak which is dark-colored while the rest of the corolla is yellow. The stem is single and unbranched with 4-verticillate pinnatisect leaves. The upper bracts are membranaceous, much dilated proximally and linear and deeply pinnatifid distally. Two of the staminal filaments are sparsely pilose.

36. Pedicularis pectinatiformis Bonati Plate 17, fig. 26.

Pedicularis pectinatiformis Bonati, in Bull. Soc. Bot. France, 54: 372, 1907; Limpricht, in Repert. Sp. Nov., 20: 263, 1924. Bonati's type was from Sikang: " Chang-Chan (Thibet oriental), 1894 [*Soulié*]." A specimen of this (ex Herb. Mus. Paris), bearing the number 2868, from the Bonati Herbarium, passes to the University of California at Los Angeles, with a photograph of it at the Academy of Natural Sciences of Philadelphia. This may be the holotype or an isotype.

In eastern Sikang. Flowers purple. Flowering in August.

SIKANG: Chang-chen, *Soulié* 2868 (B).

This species is strongly characterized by the subequal, linear, and entire calyx-teeth, the glabrous filaments, and the strongly acute and cucullate median lobe of the lower corolla-lip.

SECTION II. RIGIOCAULUS

Erect plants, the stems rigid, robust, simple or short-branched above; leaves 4-verticillate, sessile to subsessile or very short-petiolate, ovate-oblong to lanceolate, pinnatifid, the lobes serrulate; inflorescences racemose or spicate, usually long and compact, terminating the stems and short branches; calyx slightly or not cleft anteriorly, 5-dentate, the teeth small, short, equal or unequal, serrate or entire; corolla with a tube 1½ to 3 times as long as the calyx; galea either ending in a very short beak-like apex and bidentate, or with a long slender beak and without teeth.

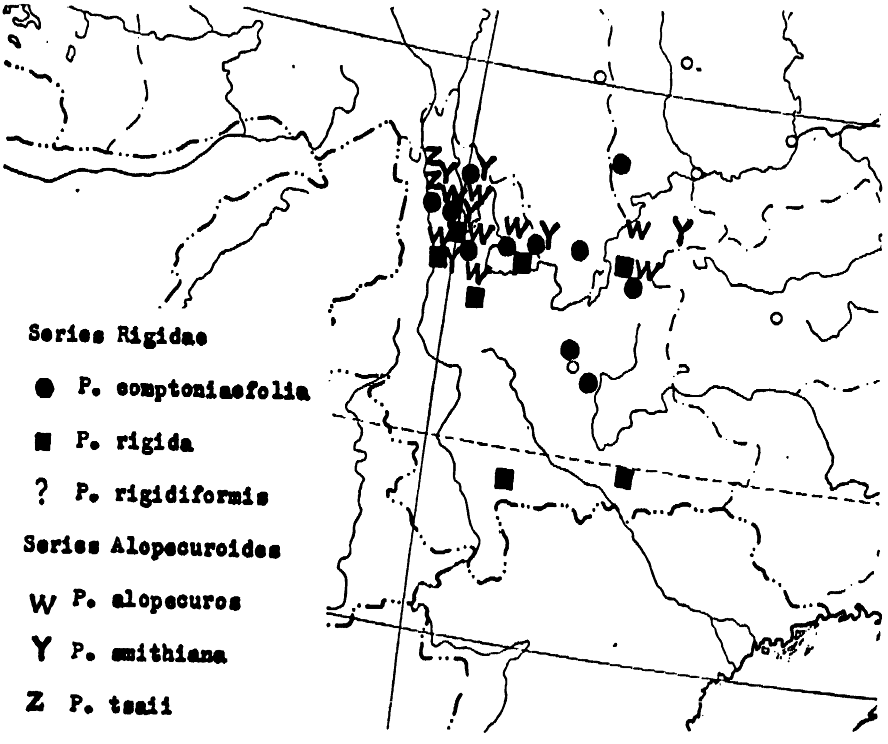
A section related to the Orthosiphonia but the species have more robust rigid stems, and bear sessile to very short-petiolate pinnatifid leaves. The two series comprising the section are more limited in distribution, being confined to the western part of the highlands of southwestern China.

Series 12. Rigidae

Rigidae Prain, in Ann. Bot. Gard. Calcutta, 3: 86, 1890.

Plants erect, robust, usually short-branching above; leaves 4-verticillate, linear- to oblong-lanceolate, pinnatifid, the lobes serrulate; inflorescence racemose or spicate; terminating the stem and the short branches, bracts similar to the leaves; calyx campanulate, 5-dentate, the teeth small, short; corolla rose to purplish, the galea terminating in a broad, short, beak-like apex, with one tooth on each margin at the lower side; lower lip about as long as, or slightly longer than, the galea.

Prain included two species, *P. comptoniaefolia* and *P. rigida* in the series Rigidae. These were originally included in the series Platyrrhynchae by Maximowicz (in Bull. Acad. St. Pétersb., 32: 586, 1888; in Mél. Biol., 12: 871, 1888). Bonati added a third species, *P. rigidiformis* in 1927. *P. comptoniaefolia* is found in the northwestern and northern parts of Yunnan, as well as in adjacent southeastern Sikang and southern Szechuan. *P. rigida* is found in northwestern to southern Yunnan. *P. rigidiformis* is known only from the type collection in Kweichow. The geographical range of the series is therefore limited to the western part of the highlands of southwestern China with the center of development in northwestern Yunnan where the largest number of collections were gathered (Map 8).



Map. 8.—Distribution of the series Rigidae and Alopecuroides.

Key to the Species

A. Plants glabrate; flowers more or less laxly arranged; corolla-tube about thrice as long as the calyx; teeth on the galea short; filaments slightly hirsute distally. 37. *P. comptoniaefolia*

AA. Plants densely pubescent; flowers densely or laxly arranged; corolla-tube about twice as long as the calyx; teeth on the galea subulate; filaments glabrous throughout or two of them villose distally.

  B. Flowers short-pedicelled, more or less compactly arranged; calyx glabrous; filaments glabrous throughout. .... 38. *P. rigida*

  BB. Flowers sessile, more or less laxly arranged; calyx villose; 2 of the filaments villose distally. .... 39. *P. rigidiformis*

37. Pedicularis comptoniaefolia Franchet Plate 17, fig. 27.

Pedicularis comptoniaefolia Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 586, fig. 96, 1888; in Mél. Biol., 12: 871, fig. 96, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 206, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 89, 1911; 7: 81, 163, 241, 1912; 8: 42, 1913; 15: 154, 1926; Limpricht, in Repert. Sp. Nov., 20: 225, 1924; 23: 335, 1927; Hand.-Maz., Symb. Sin., 7: 854, 1936. Franchet's type, "prov. Yunnan, supra Tapin-tse (Delavay! in herb. Paris.)," has not been seen. The original description and illustration are distinctive.

Dry open pastures, at altitudes of 2400 to 3000 meters, in southern, northwestern and northern Yunnan, and adjacent southeastern Sikang. Also reported from the Shan Hills, Burma (ex Prain, in Journ. As. Soc. Beng., 58 (2): 266, 1889). Flowers rose to purplish rose. Flowering from July to September.

SIKANG: no locality, *Forrest* s.n. (UCLA); Hui-li District, *Yü* 1560 (GH); Si-chang District, *Yü* 1266 (GH).

YUNNAN: no locality, *Ducloux* 916 (ANSP, UCLA); *Maire* 3929 (ANSP, UCLA); Kin-tch'ong-chóu, *Maire* s.n. (ANSP, UCLA); Pan-pien Kai & Za-kou, *Maire* 6144 (ANSP, UCLA); Tch-eou-kia-tse-tang, *Maire* 6381 (ANSP, GH, UCLA); Tong tchouan, *Maire* s.n. (ANSP, GH, UCLA); Yunnan sen, *Ducloux* 787 (ANSP, UCLA); Yunnanfu, Tai hoa sse, *Schoch* 335 (USNH); Likiang, *Schneider* 2308 (USNH), 3365 (USNH), *Ching* 30564 (AA); Chungtien, *Schneider* 3034 (USNH); eastern slopes of Likiang Snow Range, *Forrest* 2790 (ANSP, UCLA), 4487 (ANSP, UCLA), 6325 (UCLA), 7045 (UCLA), *Rock* 5663 (ANSP, GH, UC, USNH); western slopes of Likiang Snow Range, *Rock* 5339 (ANSP, GH, UC, USNH); *Ching* 21116 (AA), 21353 (AA), 21884 (AA); Ludu, northwest of Likiang, *Rock* 18521 (ANSP, USNH); Lotze Lo, between Likiang, Youngning, and Youngpei, *Rock* 5310 (USNH); Youngpei mountains, *Ten* 30 (RBGE), *Forrest* 10990 (UC, UCLA); Tali Range, *Forrest* 27986 (ANSP); Cheng-kiang, *H. Wang* 41769 (AA).

38. Pedicularis rigida Franchet Plate 17, fig. 28.

Pedicularis rigida Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 587, fig. 97, 1888; in Mél. Biol., 12: 872, fig. 97, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 214, 1890; Limpricht, in Repert. Sp. Nov., 20: 225, 1924; 23: 335, 1927; Bonati, in Notes Bot. Gard. Edinb., 15: 155, 1926; Hand.-Maz., Symb. Sin., 7: 854, 1936. Franchet's type, "Yunnan, sylvis montis Pée-ngay-tze supra Tapin-tsé (Delavay! in herb. Paris)," has not been seen. Limpricht gave this number as *Delavay* 335. One of the Delavay numbers cited below is from the type locality.

Alpine pastures or shady stony situations, at altitudes of 2500 to 3000 meters, in southern to northern Yunnan. Flowers rose to pinkish purple. Flowering in August and September.

YUNNAN: no locality, *Delavay* s.n. (UCLA), *Esquirol* s.n. (UCLA); Ta-pin-tse, *Delavay* 3683 (ANSP, UCLA); Tong-tchouan, *Maire* 6142 (ANSP, UCLA), *Ducloux* 1541 (ANSP, UCLA), *Maire* s.n. (ANSP, UCLA); Pan-pien-kai, *Maire* 6376 p.p. (ANSP, UCLA); Za-kou, *Maire* s.n. (UCLA); between Likiang and Tali, *Rock* 6546 (ANSP, UC, USNH); Young-pei mountains, *Forrest* 11040 (UCLA); Mekong Valley, *Forrest* 13063 (ANSP, UCLA); Meng-tze, *Henry* 9708 (USNH); Sze-mao, *Henry* 13413 (MBG, NYBG).

39. Pedicularis rigidiformis Bonati

Pedicularis rigidiformis Bonati, in Arch. Bot. (Caen) Bull. 1: 219, 1927. Bonati's type, "Kouey-Tcheou-Kouang-Tai-Fou, 1916 (Cavalerie)," has not been seen. The type locality is in Kweichow Province, but the exact location of the district "Kouang-Tai-Fou" cannot be found on the various maps consulted.

In Kweichow. Known from the original collection only. No specimen seen.

This species, according to Bonati, is near *P. rigida*, differing especially in 2 of the staminal filaments being hairy distally, in the very villose habit, and in the flowers being sessile.

Series 13. Alopecuroides

Alopecuroides ser. nov.

Pectinatae Prain, in Ann. Bot. Gard. Calcutta, 3: 71, 1890, p.p.

Tall erect, robust plants; stems sometimes branching at base, simple or short-branched above; leaves 3-4-verticillate, sometimes opposite and verticillate, sessile to short-petiolate, ovate-oblong to ovate-lanceolate, pinnatifid to about half the distance to the midrib, the lobes ovate and more or less contiguous; inflorescences long-spicate, compact; bracts ovate, usually dilated proximally; calyx usually slightly cleft anteriorly, the teeth 5, equal to unequal, serrate or entire; corolla yellow proximally and with purple galea, rarely purple throughout, the beak long, slender, more or less straight and horizontal, the lower lip with ciliate or glabrous margins; staminal filaments all glabrous.

About 3 species in northern Yunnan and Sikang (Map 8).

This series is segregated out of the Pectinatae of Prain. Its species differ from the Pectinatae in having taller and more robust stems, with sessile or short-petiolate and pinnatifid, instead of long-petiolate and pinnatisect leaves. Their relationship is possibly with the Rigidae.

Key to the Species

A. Corolla yellow proximally and purple distally; margins of the lower lip glabrous.
  B. Leaves sessile, opposite to 3-verticillate, oblong-lanceolate, 1-1.4 cm. broad, the lobes 12 or more on each side. .... 40. *P. alopecuros*
  BB. Leaves petiolate, 3-4-verticillate, ovate to ovate-oblong, about 3 cm. or more broad, the lobes about 6-10 on each side. .... 41. *P. smithiana*
AA. Corolla purple throughout; margins of the lower lip ciliate. .... 42. *P. tsaii*

40. Pedicularis alopecuros Franchet Plate 17, fig. 29.

Pedicularis alopecuros Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 548, fig. 33, 1888; in Mél. Biol., 12: 818, fig. 33, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 205, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 83, 1911; 7: 150, 178, 1912; 8: 39, 1913; 15: 167, 1926; Limpricht, in Repert. Sp. Nov., 20: 264, 1924; 23: 339, 1927; Hand.-Maz., Symb. Sin., 7: 870, 1936. The type, "China: Yunnan (Delavay! in Mus. Paris)," has not been seen. The original description and illustration are very distinctive.

In alpine meadows, at altitudes of 2300 to 4000 meters, in northern Yunnan and southeastern Sikang. Flowers yellow proximally, the galea and beak purple. Flowering from May through August.

WESTERN CHINA: without locality, *Wilson* 4245 (UCLA).

SIKANG: Muli, *Ward* 4565 (RBGE).

YUNNAN: no localities, *Maire* 3988 (UCLA), *Ducloux* s.n. (UCLA), *Yü* 7563 (AA), 15520 (AA); Kiao-kia, *Maire* 3828 (UCLA); Tong Tchouan, *Maire* s.n. (ANSP, UCLA), 3948 (UCLA); Za-kou, *Maire* 6140 (ANSP, UCLA); Ié-ma-tchouan, *Maire* 6371 (ANSP, UCLA); Pan-pien-kai, *Maire* 6376 p.p. (ANSP, UCLA); Tou-ke-suin, *Maire* s.n. (ANSP, UCLA), 7429 (ANSP, UCLA); Likiang, Nger-leh Reh, *Schneider* 2079 (GH, USNH); Chungtien, *Schneider* 2395 (GH, USNH); between Youngpei and Youngning, between Dsutoupo and Bei-ma Shan, *Handel-Mazzetti* 3298 (USNH); eastern slopes of Likiang Snow Range, *Forrest* 2649 (ANSP, UCLA), 6356 (UCLA), *Rock* 5709 (GH, USNH), 5870 (USNH), 9827 (ANSP, UC, USNH); near Ngaza, west of Likiang, *Rock* 10614 (USNH); Mt. Wuaha, Youngning Territory, *Rock* 24196 (UC, UP); Yong-shan District, *Tsai* 51116 (AA); Lan-ping District, *Tsai* 53726 (AA); Likiang Snow Range, *Ching* 30575 (AA).

This is a very characteristic species with strong robust stem generally short-branched above, with mostly opposite oblong-lanceolate pinnatifid leaves which are more or less fleshy, many lobed, sessile to subsessile and scabrous-puberulous on both surfaces. Its relationship is with *P. smithiana* which it closely resembles in floral structure, but nevertheless, the two can be readily distinguished by vegetative characters. *Pedicularis smithiana* has a slender stem and distinctly petiolate leaf-blades which are much broader and with fewer lobes. *P. alopecuros* has the middle lobe of the lower corolla-lip somewhat cucullate.

41. Pedicularis smithiana Bonati Plate 17, fig. 30.

Pedicularis smithiana Bonati, in Notes Bot. Gard. Edinb., 5: 83, pl. 72, 1911; 7: 153, 1912; 8: 39, 1913; 15: 167, 1926; Limpricht, in Repert. Sp. Nov., 20: 264, 1924; 23: 339, 1927; Hand.-Maz., Symb. Sin., 7: 870, 1936. Bonati's type was from northwestern Yunnan: "'Shady, grassy situations in the margins of pine forests on the eastern flank of the Lichiang Range. Lat. 27° 20′ N. Alt. 10,500-11,500 ft. August 1906.' G. Forrest. No. 2860." An isotype, from the Bonati Herbarium, is to pass to the University of California at Los Angeles, with photograph at the Academy of Natural Sciences of Philadelphia.

Pedicularis praealta Bonati, in Notes Bot. Gard. Edinb., 13: 122, 1921; Limpricht, in Repert. Sp. Nov., 20: 264, 1924. The type, "Eastern Yunnan:—'Plateau herbeux de Ié-ma-tchouan. Alt. 3,200 m. Pedicularis annual, haut. 1 m.; fl. jaunes. Aout.' E. E. Maire. No. 673," in the Edinburgh Herbarium, has been seen. A photograph is in the herbarium of the Academy of Natural Sciences of Philadelphia. The type shows that this species is identical with *P. smithiana*.

Open pastures and in thickets at altitudes of 3350 to 4000 meters, in northern Yunnan and southeastern Sikang. Flowers pale yellow with purple galea and beak. Flowering from May to August.

SIKANG: Muli Territory, Mt. Gibboh, south of Muli Gomba, *Rock* 24181 (UC, UP); Kanting, near Ta Kwan, Ta Hsiang Ling, *Chiao* 1667 (AA).

YUNNAN: Ié-ma-tchouan, *Maire* 673 (RBGE); eastern flank of the Likiang Snow Range, *Forrest* 2860 (B), 6247 (B), 10553 (ANSP, UC, UCLA), *Rock* 5014 (USNH); mountains west of Hsiao Chungtien, *Rock* 24633 (CM, NYBG, UC, UP, USNH); Mt. Habashan, north of Ndaku, north of the Likiang Snow Range, *Rock* 9650 (ANSP, UC, USNH), 9654 (USNH), *Feng* 2130 (AA); Likiang Snow Range, *Yü* 15409 (AA), *Ching* 30452 (AA); Chungtien Plateau, *Feng* 1692 (AA), 1777 (AA); no precise localities, *Forrest* 28816 (ANSP), *Yü* 12280 (AA).

This species has a flower very similar to that of *P. alopecuros;* in both, the color of the proximal portion is yellow and that of the distal purple. The calyces of both species are also similar in the shape of the teeth and in the shallow anterior cleft. However, the flowers of *P. smithiana* are larger. But the vegetative characters of the two species are very different from each other; the leaves of *P. smithiana* are membranaceous, much larger and broader, less numerously lobed, and distinctly petiolate, while those of *P. alopecuros* are much narrower and sessile.

42. Pedicularis tsaii sp. nov. Plate 17, fig. 31.

Annua, ad 5.5 dm. alta, radice parva, fasciculata, subcrassa, caule erecto, unico vel ad basim pauce ramoso, glaberrimo vel apicem versus leviter hirsuto; foliis 4-verticillatis, breviter petiolatis (petiolis 4-10 mm. longis, gracilibus, glabris, leviter alatis), membranaceis, utrinque glabris, ovato-oblongis, circiter 4.5 cm. longis et 3 cm. latis, apice obtusis, margine pinnatifidis, lobis utrinsecus 6-8, ovatis vel oblongis, 6-10 mm. longis, 4-8 mm. latis, profunde serratis, dentatis; inflorescentiis spicatis, 6-8 cm. longis, compactis vel inferne interruptis; bracteis inferioribus foliaceis, superne ovatis, calycem aequantibus vel leviter interruptis; bracteis inferioribus foliaceis, superne ovatis, calycem aequantibus vel leviter longioribus, profunde serratis; pedicellis 1-2 mm. longis; calyce cupuliformi, membranaceo, circiter 1 cm. longo, in venis ciliato, antice leviter fisso, 10-costato, superne leviter reticulato, dentibus 5, inaequalibus, posteriore deltoideo integro, caeteris ovatis distincte dentatis; corollā rubrā vel purpureā, circiter 1.6 cm. longā: tubo erecto, calycem duplo vel ultra longiore; galeā apicem versus curvatā, in rostrum gracilem productā, rostro circiter 6 mm. longo, plus minusve recto plano; labio 6-7 mm. longo, 3-lobato, margine ciliato, lobis lateralibus rotundatis, lobo medio sat parvo, porrecto, apice acuto, cucullato; staminibus ad medium tubi insertis, filamentis omnino glabris; stylo exserto; capsulis compresso-ovoideis, acutis, 1.2-1.4 cm. longis, 5-6 mm. latis.

Type, on top of Pi-lo-shan, Che-tse-lo, in northwestern Yunnan, collected in flower and fruit, Aug. 28, 1934, by H. T. Tsai, No. 58287; holotype in the herbarium of the Arnold Arboretum.

In alpine meadows, at altitudes of 4000 to 4250 meters, in northwestern Yunnan. Flowers reddish purple. Flowering in August.

YUNNAN: Pi-lo-shan, Che-tse-lo, *Tsai* 58011 (AA), 58287 (AA), 58604 (AA); Fuchuan Range, west of the Mekong-Salween divide and west of Wei-si, *Rock* 23276 (NYBG, UC, UP).

This species is closely allied to *P. smithiana,* which it resembles in vegetative appearance as well as in floral structure. However, it can be distinguished from the latter by its corolla being wholly purple or reddish and the lower lip acute and cucullate at the apex. The corolla-tube evidently elongates with age as shown by the tube being longer in fruiting specimens.

SECTION III. SIGMANTHA

Low or tall plants, the stem simple or branching at base, sometimes also branching above; leaves 4-verticillate, pinnatifid to pinnatisect, the lobes dentate to pinnatisect; inflorescences spicate to racemose; calyx cleft anteriorly or not, usually 5-dentate, sometimes fewer, the teeth entire to serrate; corolla-tube slightly longer than the calyx, strongly bending in the calyx and again curved upward above the calyx; galea with the apex either truncate, acute, or short-beaked; lower lip with the middle lobe usually smaller and more distad.

As a section this is closely related to the Orthosiphonia but with a strongly curved corolla-tube. The section has a range similar to the latter and also very close general habit. The curving of the corolla apparently facilitates the landing of certain insect-visitors.

Series 14. Verticillatae

Verticillatae Maxim., in Bull. Acad. St. Pétersb., 32: 590, 1888; in Mél. Biol., 12: 876, 1888.

Low or tall, biennial or perennial; stem simple or branching at base, sometimes also branching above, glabrous to hirsute; leaves commonly 3-4-verticillate, ovate to lanceolate, pinnatifid to pinnatisect, the radical long-petiolate, the cauline sessile to mostly short-petiolate, flowers spicately arranged; calyx mostly 10-nerved, sometimes reticulate, sometimes cleft anteriorly, 5- rarely 4- or fewer-dentate, the teeth obscure to prominent, deltoid to oblong, entire to serrate; corolla pink, purple or red, rarely white, never yellow, the tube longer than calyx, bending in the calyx, strongly deflexed; galea half as long as, to longer than, the lower lip, rounded in front, the apex truncate to slightly acute, the lower margin entire; lower lip 3-lobed, the lobes rounded, the mid-anterior usually smaller and distad; anther-pairs contiguous or discrete; fruits usually pointing straight outward, lateral.

The series Verticillatae comprises a large, variable group of species, but ones with more or less uniform fundamental characters. Prain (in Ann. Bot. Gard. Calcutta, 3: 93-97, 1890) divided it into a number of series, each consisting of a few species, but as pointed out by Bonati (in Bull. Soc. Bot. France, 57, Mém. 18: 32, 1910), these divisions are mostly without clear-cut limitations. Bonati preferred to follow the larger grouping of Maximowicz. Limpricht (in Repert. Sp. Nov., 20: 203-211, 1924) retained some of Prain's divisions and combined and united others into larger groups. Prain had proposed eleven series under his Division Erostres, Section Anodontae, Cyclophylla. I venture to combine most of them and to recognize four series, which seem to possess sufficient affinities within each group to facilitate the determination of species as well as to indicate their natural relationships. The series Verticillatae includes the bulk of the species, being those that have the fundamental type of edentate "Anodonta" corolla. This series apparently represents a relatively old group of the genus that shows a somewhat primitive level of evolution and occupies the general region that is fundamental to the genus.

The flowers of the Verticillatae have the corolla-tube more or less strongly curved and deflexed in the calyx; in this respect they can be differentiated from species of the series Abrotanifoliae, where the corolla-tube is more or less straight in the calyx, but is bent forward above the calyx at the junction of the corolla-tube and the galea. Also they differ from those of the series Cheilanthifoliae in which the corolla-tube is either straight or slightly deflexed in the calyx, its distal portion not bending forward above the calyx-tube.

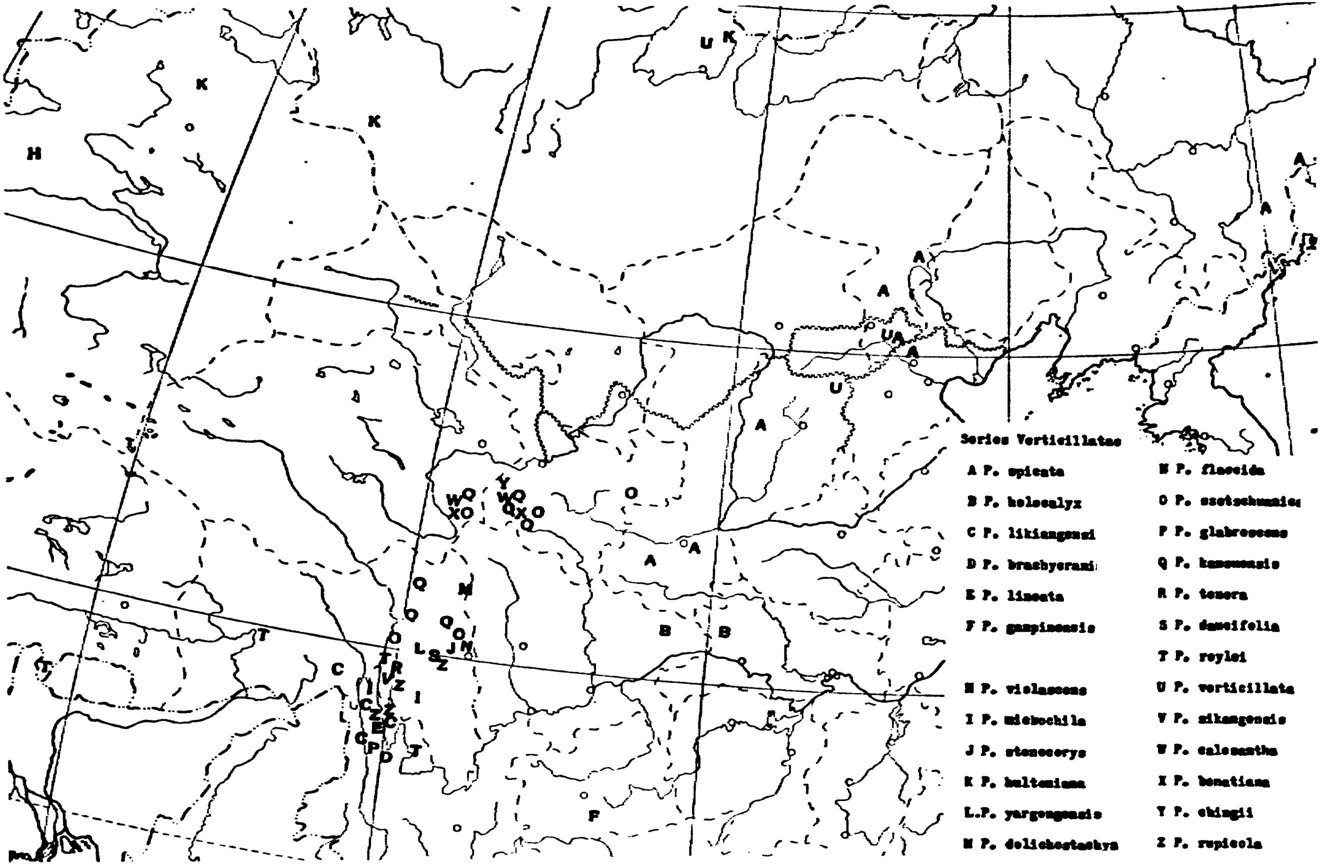
More akin to the Verticillatae is the series Plicatae. As established by Prain, it comprised originally *Pedicularis plicata* and *P. rupicola,* to which Limpricht (in Repert. Sp. Nov., 20: 206, 1924) added other species. Of these, only the species *P. plicata* is distinct enough to warrant its retention in a separate series, the others being now transferred to the Verticillatae. The series Plicatae is thus close to the Verticillatae, but is characterized by its yellow corolla with rather broad, more or less rounded galea, generally slightly enlarged distally, and by its anther-cells being long-acuminate at the bases. All species of the series Verticillatae have pink, purple, or red flowers; these are rarely white, and never yellow.

Many of the species of the series Verticillatae have the stamens with discrete anther-pairs, but in some they are contiguous. Another characteristic feature of most of the species is that the fruit, which is only occasionally collected in *Pedicularis,* points straight outward in a lateral position.

The series Verticillatae covers a wide area from Europe to northwestern North America, south to the Himalayas. It is most highly developed in the mountainous regions of western China (Map 9).

Key to the Chinese Species

A. Galea short, about one-half as long as the lower lip.
  B. Flowers small, about 10-12 mm. long; calyx small, subglobose, entire to shallowly toothed, the teeth small, rounded, entire.
    C. Spike over 5 cm. long; calyx not cleft anteriorly, 4-5-toothed, not reticulate, rather hairy; corolla more or less bent forward; lobes of the lower lip more or less fimbriate; all staminal filaments glabrous. 43. *P. spicata*
    CC. Spike 2-5 cm. long; calyx cleft anteriorly, entire or 2-toothed, reticulate distally, not or slightly hairy; corolla rather straight above the calyx; lobes of the lower lip entire-margined; 2 of the staminal filaments hairy distally. .... 44. *P. holocalyx*
  BB. Flowers larger, about 1.5-2 cm. long; calyx large, cylindric-ovoid, distinctly 5-dentate, the teeth elongate, entire or dentate.
    C. Leaves deeply pinnatifid, the lobes pinnatifid to dentate; staminal filaments all glabrous or 2 of them hairy.
      D. Calyx slightly cleft anteriorly; the teeth lanceolate, acute, usually entire, rarely dentate to slightly lobed; anterior filaments hairy. 45. *P. likiangensis*
      DD. Calyx not cleft anteriorly, the teeth deltoid, subentire to obscurely serrate; all staminal filaments glabrous. 46. *P. brachycrania*
    CC. Leaves broad, shallowly pinnatifid, the lobes dentate; calyx not cleft anteriorly; calyx-teeth broadly ovate, distinctly serrate; all staminal filaments glabrous. .... 47. *P. lineata*
AA. Galea long, usually about as long as the lower lip (sometimes slightly shorter or occasionally longer than it).
  B. Calyx with the nerves reticulate; 2 of the staminal filaments hairy. 48. *P. ganpinensis*



Map. 9.—Distribution of the series Verticillatae.

BB. Calyx with only primary nerves, not reticulate; all staminal filaments glabrous or 2 of them hairy.

C. Calyx not cleft anteriorly, with generally 5, sometimes 4, equal to subequal teeth, the teeth symmetrically placed; corolla extending upward or decurving at the upper opening of the calyx.

D. Corolla strongly upcurved at the junction of the tube and the galea; galea much longer than the lower lip; calyx-teeth obscurely serrate.

E. Leaves pinnatisect, the segments lanceolate, pinnatifid to dentate; calyx densely hairy, the teeth deltoid; galea 1½ times as long as the lower lip; anther-pairs contiguous; 2 of the staminal filaments hairy. .... 49. *P. violascens*

EE. Leaves pinnatifid, the lobes ovate, dentate; calyx slightly hairy, the teeth ovate, galea 1½ to 2 times as long as the lower lip; anther-pairs more distant.

F. Lobes of the lower lip with margins entire; all staminal filaments glabrous. .... 50. *P. microchila*

FF. Lobes of the lower lip with margins fimbriate; 2 of the staminal filaments hairy. .... 51. *P. stenocorys*

DD. Corolla not strongly upcurved at the junction of the tube and the galea, more or less straight or slightly curved above; galea as long as the lower lip or slightly shorter.

E. Calyx-teeth triangular to triangular-oblong, entire or nearly so; staminal filaments all glabrous.

F. Leaves pinnatisect, the segments oblong to linear, pinnatifid to nearly pinnatisect.

G. Leaf-segments 8-12 on each side; calyx 3-4 cm. long; anther-pairs contiguous. .. 52. *P. hulteniana*

GG. Leaf-segments 11-15 on each side; calyx 6-7 mm. long; anther-pairs more distant.
53. *P. yargongensis*

FF. Leaves pinnatifid, the lobes ovate, subentire to dentate.

G. Stems not branching above; leaves 2.5-3 cm. long, the segments 6-8 on each side, acute, subentire; calyx-teeth deltoid, broadened at base; anther-pairs contiguous. .... 54. *P. dolichostachya*

GG. Stems branching above; leaves 1 cm. long, the segments 5-6 on each side, obtuse, incised-dentate; anther-pairs more distant. ... 55. *P. flaccida*

EE. Calyx-teeth triangular-ovate to ovate or oblong, more or less dentate to serrate; staminal filaments glabrous or 2 of them hairy.

F. Leaves pinnatifid, the lobes ovate, subentire to dentate; all staminal filaments glabrous. ... 56. *P. szetschuanica*

FF. Leaves pinnatisect, the segments oblong to linear, pinnatifid to pinnatisect; staminal filaments all glabrous or 2 of them hairy.

G. Two of the staminal filaments hairy.

H. Plants tall, 10-15 cm. or more tall; calyx-teeth triangular to ovate, more or less broadened at base.

I. Plant glabrate; leaf-segments broad, approximate; calyx glabrate, the teeth more or less ovate, sharply dentate; corolla 1.3 cm. long; anther-pairs contiguous; stigmas included.
57. *P. glabrescens*

II. Plant pubescent; leaf-segments narrower, remote; calyx pubescent, the teeth triangular, inconspicuously dentate; corolla 1.8 cm. long; anther-pairs more distant; stigmas exserted. ..... 58. *P. kansuensis*

HH. Plant low, hardly 7 cm. tall; calyx-teeth oblong, slightly narrowed proximally. 59. *P. tenera*

GG. All staminal filaments glabrous.

H. Calyx glabrous, the teeth equal, ovate; anther-pairs more distant. .. 60. *P. daucifolia*

HH. Calyx hairy, the teeth more or less unequal, oblong-triangular to mostly ovate; anther-pairs contiguous. .... 61. *P. roylei*

CC. Calyx cleft anteriorly, 4-5-dentate, the teeth equal to unequal, more or less grouped posteriorly; corolla extending outward laterally through the cleft of the calyx.

D. Calyx-teeth small, sometimes inconspicuous, deltoid, entire to obscurely serrate; staminal filaments all glabrous or 2 of them hairy.

E. Stems branching at base only, not branching above; leaves pinnatifid to pinnatisect, the lobes serrate to pinnatifid; staminal filaments all glabrous or 2 of them hairy.

F. Staminal filaments all glabrous. .... 62. *P. verticillata*

FF. Two of the filaments hairy.

G. Plants more or less subglabrate; leaves ovate-oblong to oblong-lanceolate; calyx subglabrate, entire or with 2 or more very obscure teeth.

H. Stems usually several, of equal length; leaves with 6-7 pairs of segments, the segments to 3 mm. broad; corolla purple; galea broader, about 2.5 mm. wide. 63. *P. sikangensis*

HH. Stems usually single or with a few short branches from the base; leaves with 8 pairs of segments, the segments to 2 mm. wide; corolla pink to pinkish purple; galea narrower, about 2 mm. wide. .. 64. *P. calosantha*

GG. Plant strongly hirsute; leaves lanceolate; calyx hirsute, irregularly 5-dentate. ... 65. *P. bonatiana*

EE. Stems somewhat woody, freely branched above; leaves pinnatisect, the segments pinnatisect and dentate; 2 of the staminal filaments hairy. .... 66. *P. chingii*

DD. Calyx-teeth broad, ovate, distinctly lobulate-serrate; staminal filaments all glabrous. .... 67. *P. rupicola*

Status uncertain. .... 68. *P. lingelsheimiana*

43. Pedicularis spicata Pallas Plate 17, fig. 32.

Pedicularis spicata Pallas, Reise, 3: 738, pl. S, fig. 2 B, 1776; Maxim., in Bull. Acad. St. Pétersb., 24: 64, 1887; 32: 597, fig. 117, 1888; in Mél. Biol., 10: 97, 1878; 12: 886, fig. 117, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 216, 1890; Palibin, in Act. Hort. Petrop., 14: 134, 1895; Diels, in Bot. Jahrb., 29: 572, 1900; Komarov, in Act. Hort. Petrop., 25: 450, 1907; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; in Repert. Sp. Nov., 20: 205, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 121, 220, 1934. Pallas' type: "Lecta in frigidissimis alpium Dauuricarum paludibus [*Pallas*]," has not been seen. Authentic specimens from Siberia are at hand for reference. The northern Chinese specimens enumerated here are identical with these Siberian specimens and clearly belong to the same species.

Mountain sides, at altitudes of 1500 to 2500 meters, in Siberia and northern China from Manchuria to Mongolia, Hopei, Chahar, Jehol, Shansi, and Shensi. Flowers deep pink. Flowering in July and August.

MANCHURIA: Lake Hanka, *Przewalski* s.n. (NYBG); Manchuria, *Bohnhof* 264 (NYBG); between Ninguta and Omoso, *Komarov* 1415 (NYBG); Hingan, *Dorsett* 3738 (ANSP, NYBG, UC, USNH); Haritun, *Stötzner* 73 (NYBG).

HOPEI: Hsiao Wu-tai-shan, *Meyer* 1120 (GH, NYBG), *Kung* 953 (RBGE), *J. C. Liu* 949 (UC), 1803 (UC), 1816 a[15] (UC), 2312 (NYBG); Pohaushan *Hsia* 2232 (NYBG); Choluhsien, *Hsia* 2432 (RBGE).

SHANSI: Fan-shan District, Kwan-de Shan, *Ling* 1791 (UC); Hsiatschuan, Yaoschan, *Licent* 12518 (GH).

44. Pedicularis holocalyx Handel-Mazzetti Plate 17, fig. 33.

Pedicularis szetschuanica Maxim. var. *elata* Bonati, in Bull. Soc. Bot. France, 54: 187, 1907; Limpricht, in Repert. Sp. Nov., 20: 205, 1926. Bonati's type, "[*Wilson*] n° 2119, Hupeh," is in the Paris Museum. Isotypes seen in the New York Botanical Garden and the United States National Herbarium. This number was collected by E. H. Wilson for J. Veitch & Sons. Bonati described the calyces as 5-dentate and the staminal filaments as glabrous, but in these isotypes, the calyces are mostly obscurely 2-lobed and 2 of the filaments are hairy distally. In these respects, it is actually in contrast to, instead of resembling, *P. szetschuanica* as Bonati originally stated. Handel-Mazzetti (l.c.) remarked, "Das Wiener Exemplar der Originalaufsammlung hat den kelchsaum vollkommen ungezahnt, bzw. die Zähne zu zwei nur schwach gezähnten, breiten, runden Lappen verwachsen," which is exactly the state seen in these isotypes.

Pedicularis spicata Pall. var. *australis* Bonati, in Bull. Herb. Boiss. II, 7: 545, 1907; Limpricht, in Repert. Sp. Nov., 20: 206, 1924. Bonati's type was labelled "(Typus in herb. Barbey-Boisser) . . . Hab. District de Tchen-Keou-Tin (Farges n° 914)." Isotypes (ex herb. Mus. Paris) are in the Bonati Herbarium, the herbaria of The Academy of Natural Sciences of Philadelphia, and the New York Botanical Garden. This number is from "Tchen-kéou-tin, Héou-pin," Szechuan Province. In addition, there are two sheets of *Farges* s.n. (ex Herb. de M. de Coincy) in the Bonati Herbarium labelled only "Sutchuen or." These may or may not be of the same type collection. Bonati described the filaments as glabrous, but in the isotypes, I find two of the filaments distinctly hairy distally, while the other two are completely glabrous. The isotypes show that this variety is identical with *P. szetschuanica* var. *elata* also described by Bonati.

Pedicularis holocalyx Hand.-Maz., Symb. Sin., 7: 849, 1936. Handel-Mazzetti raised Bonati's *P. szetschuanica* var. *elata* to specific rank, but used another name because of the earlier *P. elata* Willd. Handel-Mazzetti gave no description, and the original description of Bonati, on which Handel-Mazzetti's species is based, is very brief. Hence a full description is given here.

Perennial, stem single, erect, 3-4 dm. tall, hairy on younger parts, soon glabrate. Leaves 3- or 4-verticillate, more or less distinctly petiolate, the blade ovate-oblong in outline, about 2-4 cm. long, sometimes to 7 cm., 1-2 cm. wide, slightly pubescent to glabrate, deeply pinnatifid, the lobes 6 to 8 on each side, ovate-oblong, subentire to crenate or dentate, obtuse; petioles 2-3 mm. long in the upper leaves, to 1-1.5 cm. long in the lower ones. Inflorescences terminal, spicate, 2-5 cm. long, more or less villose, the flowers compactly and densely arranged, the bracts ovate, pinnately toothed or crenate, more or less villose; pedicels in anthesis less than 1 mm. long, the lower becoming 2-3 mm. long in fruit. Calyx about 3 mm. long, slightly villose to glabrate, entire or usually with two rounded lobes about 1.5 mm.

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[15] *Liu* 1816 contains two elements, here designated as (a) and (b), the latter being *P. chinensis*.

long, reticulate distally. Corolla purplish-red, glabrous; tube about 5 mm. long, bending in the calyx, deflexed, straight and gradually enlarged distally; galea about 2.5-3 mm. long, more or less straight, rounded in front, entire on the lower margin; lower lip spreading, about 5-6 mm. long, the lobes rounded, entire, the mid-anterior slightly smaller. Stamens inserted near the base of the tube, 2 of the filaments glabrous and 2 hairy toward the upper end; anthers glabrous, the cells ovate, slightly acute at base. Capsules more or less compressed, oblong, 9-11 mm. long, 3-4 mm. wide, long attenuate-acuminate, pointing straight outward.

At an altitude of about 2000 meters, in western Hupeh and eastern Szechuan. Flowers purplish red. Flowering in June.

HUPEH: no locality, *Henry* 6744 (USNH); western Hupeh, *Wilson* 2119 (NYBG).

SZECHUAN: no locality, *Farges* s.n. (UCLA); Tchen-kéou-tin, Héou-pin, *Farges* 914 (ANSP, NYBG p.p., UCLA).

This species is allied to *P. spicata,* which it resembles in general appearance. However, it differs from the latter in many important characters and is clearly distinct. Its leaves, compared with those of *P. spicata,* are broader, more glabrous, and with longer petioles. The branches, if any, are short, and the inflorescences are very short and compact. The calyces are more glabrous, and entire or more usually 2-lobed, the lobes reticulate distally. The corolla is smaller, almost straight above the calyx, and the lobes of the lower lip entire-margined, while 2 of the staminal filaments are hairy distally. Geographically, this new species is limited to western Hupeh and adjacent eastern Szechuan, north to the Tsinling Range, while *P. spicata* occurs north of that range and is very widely distributed in the colder regions of northeastern Asia.

To *P. szetschuanica,* this species is only remotely related. From it as now redefined, this differs manifestly by its short galea and its cleft calyx.

45. **Pedicularis likiangensis** Franchet Plate 17, fig. 34.

Pedicularis likiangensis Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 597, fig. 119, 1888; in Mél. Biol., 12: 887, fig. 119, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 211, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 91, 1911; 7: 82, 1912; 8: 43, 1913; 15: 148, 1926; Limpricht, in Repert. Sp. Nov., 20: 206, 1924; 23: 233, 1927; Staff Bot. Gard. Edinb., in Notes Bot. Gard. Edinb., 17: 90, 1929; Hand.-Maz., Symb. Sin., 7: 849, 1936. Franchet's type, "Yunnan, Likiang, Sueechan, 4000 m.s.m. (Delavay! in herb. Paris)." has not been seen. Bonati had probably seen the type, his identification of Rock's and Forrest's specimens agreeing closely with the original description and illustration, and without doubt his interpretation of the species is correct. There is some variation in the size of the plant, as shown under the next entry.

Pedicularis lineata Franch. var. *dissecta* Bonati, in Notes Bot. Gard. Edinb., 15: 148, 1926; Limpricht, in Repert. Sp. Nov., 23: 333, 1927. Bonati's type was from "'Yunnan: Mountains of Moting, northeast of the Yangtze-Mekong watershed. 14-15,000 ft. Flowers purple, grassy slope. June 1923.' J. F. Rock. No. 10,341." Isotypes are in the herbarium of the Academy of Natural Sciences of Philadelphia, the Gray Herbarium, the herbarium of the University of California, and the United States National Herbarium. A close examination of the specimens proves that they are identical with *P. likiangensis.* Not only the leaves are deeply dissected like those of the latter, but also the floral structures, such as the lanceolate and entire-margined calyx-lobes and the 2 hairy staminal filaments, agree closely with *P. likiangensis* rather than with *P. lineata*. This is a rather low plant, of about 5 cm. in height, and apparently represents an extreme dwarf form of *P. likiangensis*. However, it is so well connected with the typical form of the species by all grades of intermediates that it does not seem necessary to separate it from the latter.

Alpine meadows and open stony pastures on mountain slopes, at altitudes of 3200 to 4600 meters, in northwestern Yunnan and southern Sikang. Flowers purplish-red. Flowering from June to August.

SIKANG: Glacier Lake, *Ward* 4204 (RBGE); Tsarung, mountains of Tjonatong, Upper Salween River, *Rock* 22323 (NYBG, UC, UP, USNH); Tsa-wa-rung, Gerda, Ree-su-la, *C. W. Wang* 65975 (AA).

YUNNAN: no localities, *Forrest* s.n. (UCLA), 28641 (ANSP), *Yü* 8955 (AA), 11732 (AA); Tsekou, *Soulié* s.n. (UCLA), *Monbeig* 78 (UCLA); Mekong-Salween divide, *Forrest* 14710 (ANSP, UCLA); Sila, Mekong-Salween divide, *Soulié* 1169 (ANSP, UCLA), *Yü* 22123 (AA), 22385 (AA); Maya, Mekong-Salween divide, *Handel-Mazzetti* 9649 (USNH); Fuchuan Range, Mekong-Salween divide, *Rock* 22736 (NYBG, UC, UP), 23269 (CM, NYBG, UC, UP, USNH), 23298 (NYBG, UC, UP); Londrela, Mekong-Salween divide, *Yü* 23184 (AA); Bei-ma Shan, *Forrest* 19611 (UCLA); mountains of Moting, northeast of the Yangtze-Mekong watershed, *Rock* 10341 (ANSP, GH, UC, USNH), 23343 (NYBG, UC, UP), 23337 (NYBG, UC, UP, USNH); Chungtien, mountains of Hsiao Chungtien, *Rock* 24644 (CM, MBG, NYBG, UC, UP, USNH), 25268 p.p. (UC, p.p. flowering specimen[16]); Chungtien Plateau, *Feng* 1471 (A), 1606 (AA); Likiang Snow Range, *Forrest* 6096 (UCLA), *Rock* 4940 (USNH), 5464 (ANSP, GH, UC, USNH), 9434 (ANSP, USNH); Yu-lung Shan, Likiang Snow Range, *Rock* 25319 (NYBG, UC, UP, USNH); A-tung-tze, *C. W. Wang* 64815 (AA), 68872 (AA), 68821 (AA), 68952 (AA); Wei-si District, *C. W. Wang* 64622 (AA), 68580 (AA); Che-tze-lo, *Tsai* 58049 (AA), 58215 (AA).

In the short galea, *P. likiangensis* is apparently most closely allied to *P. lineata*. However, it is readily distinguished from the latter by the much more pinnatifid leaves, the anteriorly cleft calyx, and the longer, narrower calyx-lobes which are usually entire but sometimes become serrate or slightly lobed. Its general appearance also suggests *P. rupicola* with which it is sometimes confused in the herbarium, but the longer galea of the latter immediately distinguishes it.

46. Pedicularis brachycrania sp. nov. Plate 17, fig. 35.

Biennis vel perennis (?), radice parvā subcrassā; caulibus multis erectis gracilibus simplicibus glabris vel parcius pubescentibus, ad 30 cm. altis, internodiis ad 12 cm. longis; foliis 3- vel 4-verticillatis, radicalibus paucis longe petiolatis (petiolis 1.5-2 cm. longis, haud alatis), caulinis breviter petiolatis (petiolis 2-7 mm. longis, haud alatis), glabris membranaceis, ovato-oblongis, ad 2.5 cm. longis et 1.3 cm. latis, apice obtusis, pinnatisectis, rhachidibus leviter alatis, segmentis utrinsecus 5 vel 6, ovato-oblongis pinnatifidis ad 7 mm. longis et 5 mm. latis; inflorescentiis spicatis terminalibus ad 10 cm. longis, fasciculis inferioribus discretis, superioribus compactis, bracteis ovato-oblongis vel oblongo-lanceolatis pinnatisectis vel pinnatifidis; pedicellis 2-3 mm. longis; calyce late ovato, circiter 4 mm. longo sparse hirsuto, 10-costato, 5-dentato, dentibus plus minusve aequalibus deltoideis vix 1 mm. longis, integris vel obscure dentatis; corollā purpureā omnino glabrā circiter 1.6 cm. longā: tubo circiter 8-9 mm. longo in calyce incurvato, superne recto; galeā plus minusve rectā circiter 3.5-4 mm. longā, fronte rotundatā, apice inferiore truncatā, margine inferiore integrā; labio circiter 7-8 mm. longo, lobis rotundatis integris, lobo medio parvo porrecto; staminibus ad basim tubi insertis, filamentis glabris, antheris plus minusve contiguis, loculis basi obtusis; capsulis ignotis.

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[16] See *P. rupicola typica*.

Type, in Lao-chun Shan, southwest of Shi-ku and the Yangtze, Yunnan Province, collected in flower, May 1932, by J. F. Rock, No. 25090; holotype in the United States National Herbarium; isotypes in the herbaria of the Chicago Natural History Museum, the Missouri Botanical Garden, the New York Botanical Garden, the University of California, and the University of Pennsylvania. Flowers purple.

YUNNAN: Lao-chun Shan, *Rock* 25090 (CNHM, MBG, NYBG, UC, UP, USNH).
SIKANG: Glacier Lake, *Ward* 4699 (RBGE).

This species is clearly allied to *P. likiangensis* and *P. lineata*, being closest to the latter. To both species it is related by its rather short galea. From *P. likiangensis* it can be distinguished by its more delicate stems, its more membranaceous leaves, its calyx being not cleft anteriorly and with short deltoid teeth, and its staminal filaments being wholly glabrous. To *P. lineata* it is very similar in general habit and floral structure but can nevertheless be readily distinguished from it by its deeply pinnatisect leaves, broader, straighter and shorter corolla-tube, narrower lower lip, and its calyx-teeth being deltoid and subentire to obscurely serrate instead of ovate and distinctly serrate.

47. Pedicularis lineata Franchet Plate 17, fig. 36.

Pedicularis lineata Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 597, fig. 118, 1888; in Mél. Biol., 12: 887, fig. 118, 1888; Forbes & Hemsl., in Journ. Soc. Bot., 26: 211, 1890; Diels, in Bot. Jahrb., 36, Beibl. 82: 97, 1905; Bonati, in Notes Bot. Gard. Edinb., 5: 91, 1911; 7: 241, 1912; 15: 148, 1926; Limpricht, in Repert. Sp. Nov., 20: 206, 1924; 23: 333, 1927; Hand.-Maz., Symb. Sin., 7: 849, 1936. Franchet's type was from: "Yunnan, ad angustias Yen-tze-hay supra Lankong, 3500 m. s. m. (Delavay!)." A specimen at the New York Botanical Garden, *Delavay* s.n. collected in 1886, is probably an isotype. The characteristically broad and more or less shallowly pinnatifid leaves and the short galea, as clearly depicted by Maximowicz, are safe guides to the identification of the specimens.

Alpine meadows, at altitudes of 2800 to 4570 meters, in northwestern Yunnan. Flowers purple to red. Flowering from April to July.

YUNNAN: Yen-tze-hay, *Delavay* s.n. (NYBG); slopes of Mt. Gi-na lo-ko, Yu-lung Shan, *Rock* 24996 (ANSP, NYBG, UC, USNH); eastern slopes of Likiang Snow Range, *Rock* 4960 (ANSP, USNH), 9419 (USNH); eastern slopes of Mt. Dyinaloko, northern peak of Likiang Snow Range, *Rock* 10437 (ANSP, UC, USNH); Likiang District, *C. W. Wang* 71144 (AA), 71673 (AA); Litiping, between Likiang and Wei-si, *Ching* 20903 (AA); Chengkang Snow Range, *Yü* 16916 (AA); Wei-si District, *C. W. Wang* 67681 (AA).

In the broad and shallowly pinnatifid leaves, this species resembles *P. ganpinensis*, *P. flaccida*, etc., but it is readily distinguished by the very short galea. In the latter character, it is closely related to *P. likiangensis* which differs from the present species in the strongly dissected leaves.

48. Pedicularis ganpinensis Vaniot Plate 17, fig. 37.

Pedicularis ganpinensis Vaniot ex Bonati, in Bull. Acad. Geogr. Bot., 13: 245, 1904; Limpricht, in Repert. Sp. Nov., 20: 210, 1924. Vaniot's type, "'Kouy-Tchéou, environs de Gan-pin-kien. Commun dans les herbages de la montagne, près la ville—fleurs roses pourpe' Leg. Bodinier 29. 4 1897 nº 1545," has not been seen. The specimens referred to below, all from Kweichow and one of them from the type locality, agree very well with the original description. This species was reduced to the synonymy of *P. refracta* Maxim. by Limpricht (in Repert. Sp. Nov., 23: 333, 334, 1927). *P. refracta* Maxim. is a Japanese species, and the Chinese plants referred to by Maximowicz, etc., prove to be actually *P. ganpinensis*.

"*Pedicularis refracta*" *sensu* Maxim., in Bull. Acad. St. Pétersb., 32: 600, fig. 124, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 214, 1890; Limpricht, in Repert. Sp. Nov., 20: 204, 1924, p.p.; 23: 333, 1927; *non* Maxim. 1881. In 1881 Maximowicz (in Bull. Acad. St. Pétersb., 27: 517; in Mél. Biol., 11: 289) raised his *P. verticillata* Linn. var. *refracta* Maxim. (in Bull. Acad. St. Pétersb., 24: 62, 1878; in Mél. Biol., 10: 95, 1878) to specific standing. This was described from a Japanese plant: "In *Kiusiu* alpinis: Kumamoto in sylvis *Cryptomeriae*, et in alpe vicina Kiponsan, alte supra mare, in pratis alpinis (cum *lusu albifloro*), nec non in monte Naga." In 1888, he credited the first Chinese specimen (*Perry* s.n. in herb. Paris, from Kweichow) to this species, but said: "Specc. 2 florentis parvula huc cum dubio refero ob calycem reticulatum et filamenta pilosa." A comparison of the Chinese specimens with authentic specimens of *P. refracta* Maxim. from Japan shows that the Chinese plants are taller (about 3 dm. high), rather hirsute on both stems and leaves, and with hirsute calyces, relatively long corolla-tube, 2 staminal filaments hirsute near the apex, and contiguous anther-pairs; while in *P. refracta* Maxim. of Japan, the plants are lower (less than 2.5 dm. high) and with glabrous leaves and almost glabrous stems, glabrous calyces, relatively shorter corolla-tube, all 4 staminal filaments hirsute near the apex, and widely discrete anther-pairs. Evidently the Chinese plants, though closely related to the Japanese *P. refracta* Maxim., represent a separate entity.

On mountains at an altitude of about 1300 meters, in Kweichow. Flowers rose purple to white. Flowering in June.

KWEICHOW: Gan-pin, *Esquirol* s.n. (ANSP, UCLA); Pin-fa, *Esquirol* 479 (UCLA), 2311 (ANSP, UCLA), *Cavalerie* 960 (ANSP, UCLA).

49. Pedicularis violascens Schrenk Plate 18, fig. 38.

Pedicularis violascens Schrenk, in Bull. Phys. Math. Acad. St. Pétersb., 1: 79, 1842; Fisch. & Meyer, Enum. Alt. Pl. Nov. Schrenk, 22, 1842; Benth., in DC., Prodr., 10: 563, 1846; Maxim., in Bull. Acad. St. Pétersb., 32: 594, fig. 112, 1888; in Mél. Biol., 12: 883, fig. 112, 1888; Limpricht in Repert. Sp. Nov., 20: 208, 1924. Schrenk's type is from Dzungaria: "In alpibus Dschabyk [Songaria], d. 12-20 Julii m. lecta." A specimen in the New York Botanical Garden, *Schrenk* 741, bearing the same locality but no date, is probably an isotype.

At altitudes of 4000 to 4300 meters, in Dzungaria and Chinghai. Flowers purple.

DZUNGARIA: Dschabyk, *Schrenk* 741 (NYBG); in montibus Alatau, *Schrenk* 1072 (ANSP).

50. Pedicularis microchila Franchet Plate 18, fig. 39.

Pedicularis microchila Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 595, fig. 113, 1888; in Mél. Biol., 12: 884, fig. 113. 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 212, 1890; Bonati, in Bull. Soc. Bot. France, 54: 186, 1907; in Notes Bot. Gard. Edinb., 5: 90, 1911; 7: 241, 1912; Limpricht, in Repert. Sp. Nov., 20: 207,

1924; Staff Bot. Gard. Edinb., in Notes Bot. Gard. Edinb., 17: 227, 1924. Franchet's type was from "Yunnan, monte Tsang-chan supra Tali, 3800 m.s.m. (Delavay!)." A sheet of *Delavay* s.n., from Yunnan, labelled *P. microchila* Franch., and presumably an isotype, is in the Bonati Herbarium; its specimens will pass to the University of California at Los Angeles and to the Academy of Natural Sciences of Philadelphia.

Alpine meadows or margins of thickets by streams, at altitudes of 2750 to 4000 meters, in northwestern Yunnan and southeastern Sikiang. Flowers rose. Flowering from June to August.

WESTERN CHINA: no precise locality, *Wilson* 4247 (UCLA).

SIKANG: Muli Territory, Mt. Gibboh, south of Muli Gomba, *Rock* 24189 (CM, NYBG, UC, UP, USNH).

YUNNAN: no locality, Delavay s.n. (ANSP, UCLA); Salween Valley, *Forrest* 16802 (ANSP, UCLA); eastern flank of the Tali Range, *Forrest* 4486 (ANSP, UCLA); northern flank of Haba Snow Range, *Feng* 2223 (AA); Upper Kiukiang (Clulung) Valley, Chialahmuto, *Yü* 19751 (AA).

This species is strongly characterized by the corolla being manifestly deflexed to the junction of the tube and the galea, and the galea being long and narrow, about twice as long as the lower lip. It was made to represent a distinct series "Microchila" by Prain (in Ann. Bot. Gard. Calcutta, 3: 93, 1890).

51. **Pedicularis stenocorys** Franchet

Pedicularis stenocorys Franch., in Bull. Soc. Bot. France, 47: 32, 1900; Bonati, in op. cit., 54: 186, 1907; Limpricht, in Repert. Sp. Nov., 20: 207, 1924. Franchet's type was from Sikang: "Su-tchuen, environs de Ta-tsien-lou (Mussot, n. 304)." It has not been seen.

Near Kanting, Sikang Province. Known from the original collection only. No specimen seen.

According to the description this species is characterized by the long narrow galea which is about twice as long as the lower lip. In this respect it closely approaches *P. microchila*. It can be differentiated from the latter by the margin of the lower lip being fimbriate, and by two staminal filaments being hairy.

52. **Pedicularis hulteniana** sp. nov. Plate 18, fig. 40.

Pedicularis amoena β Adams ex Stev., in Mém. Soc. Nat. Mosc., 6: 26, 1823.

"*Pedicularis amoena*" *sensu* Bunge, in Ledebour, Flora Ross., 3: 271, 1849; Maxim., in Bull. Acad. St. Pétersb., 32: 596, fig. 115, 1888; in Mél. Biol., 12: 886, fig. 115, 1888; Limpricht, in Repert. Sp. Nov., 20: 208, 1924, p.p.; *non* Adams.

Perennis; radicibus plurimis cylindricis crassis; caulibus singulis vel basi ramosis aliis simplicibus, erectis, 8-30 cm. altis, leviter hirsutis vel glabrescentibus; foliis radicalibus multibus vel sparsis longe petiolatis (petiolis 3-4 cm. longis gracilibus interdum subalatis), caulinis 4-verticillatis, longe vel breviter petiolatis (petiolis 3-5 mm. longis, hirsutis vel glabris), ovato-oblongis vel oblongo-lanceolatis, sparse hirsutis vel glabris, circiter 2.5-4 cm. longis, 1-1.5 cm. latis, acuminatis, pinnatisectis, rhachidibus alatis, vix 1 mm. latis, segmentis utrinsecus 8-12, distantibus, linearibus, acuminatis, distincte serratis; inflorescentiis terminalibus spicatis, 2-8 cm. longis, fasciculis superioribus compactis, inferioribus remotis; pedicellis 1-2 mm. longis; bracteis conspicuis, inferioribus foliaceis, pinnatisectis vel pinnatifidis, superioribus trifidis pinnatisectis vel pinnatifidis; calyce cupulaeformi membranaceo 10-costato haud reticulato sparse hirsuto vel glabro, circiter 3-4 mm. longo, valde distincte 5-dentato, dentibus triangulari-lanceolatis, circiter 2-3 mm. longis, 1-1.5 mm. latis, integris vel obscure dentatis, acuminatis; corollā purpureā vel albā (?), circiter 1.5 cm. longā: tubo 1 cm. longo, in calyce plus minusve recto, supra calycem subinde deflexo, superne leviter curvato, superne dilatato; galeā circiter 5 mm. longā, paulo curvatā, fronte plus minusve rotundatā leviter cristatā, apice integrā; labio inferiore galeam subaequante, 3-lobato, margine glabro, lobis lateralibus rotundatis, lobo medio sat parvo porrecto, apice plus minusve truncato vel emarginato; staminibus ad basim tubi insertis, antheris glabris, loculis basi acutis, filamentis posterioribus basi sparse hirsutā exceptā glabris; stylo exserto; capsulis ignotis.

Type, in Alatau, Dzungaria, collected in flower, June 1840, by A. G. Schrenk, No. 1073; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia.

On mountain slopes, at altitudes of 2000 to 2500 meters, in the Altai region of northern Sinkiang and northern Mongolia and adjacent regions in Siberia. Flowers crimson to purple or white (?). Flowering from June to August.

MONGOLIA: Kentei mountains, *Ikonnikov-Galitzky* 2764 (UC), 2805 p.p. (NYBG); Baga Bigdo, Altai Mountains, *Chaney* 263 (UC, USNH).

DZUNGARIA: *Schrenk* s.n. (USNH), 1073 (ANSP).

SIBERIA: Altai, *Ledebour* s.n. (NYBG), *Fischer* s.n. (NYBG), *Politow* s.n. (NYBG), *Schischken & Sumnevicz* s.n. (NYBG); Altai, Syr-Darja, *Kultiassov* s.n. (NYBG), Turkestan, *Regel* s.n. (NYBG); Semipalatinsk region, *Krylov & Sergievskaya* s.n. (NYBG).

Pedicularis amoena Adams (ex Stev. in Mém. Soc. Nat. Mosc., 6: 25, pl. 7, 1823) was originally described from plants "Im Camtschatca et insulis Curilis (*Steller*); versus ostia Lenae (*Adams*); β in montibus Altaiensibus (*Schangin*)." The var. β, for which no name is given, is described only as "flore albo." Two figures are given, A and B, each with habitat sketches and floral dissections. They do not show any essential differences except that A is a lower plant with shorter leaves and shorter petioles. It is uncertain whether the figure B is for the var. β or not. Subsequent authors, for instance Ledebour (in Flora Ross., 3: 271, 1849), followed Adams' treatment. Maximowicz (in Bull. Acad. St. Pétersb., 24: 63, 1878; in Mél. Biol., 10: 97, 1878) interpreted the species as occurring from the Kurile Islands, Kamchatka, through the Altai region to western Himalaya, but later (in Bull. Acad. St. Pétersb., 27: 517, 1881; 32: 597, fig. 122, 1888; in Mél. Biol., 11: 288, 1881; 12: 891, fig. 122, 1888), he separated the western Himalayan plant as *P. roylei* and illustrated the northern Mongolian plant as *P.*

amoena (l.c., 32: 596, fig. 115, 1888; l.c., 12: 886, fig. 115, 1888). Hultén in his Flora of Kamchatka and the Adjacent Islands (in Svensk. Vet. Akad. Handl., III, 8^2: 111-113, 1930) recognized the Kamchatkan plant as *P. eriophora* Turcz. and suspected doubtfully that the Kamchatkan plant was included by Steven in the original *P. amoena*, which is evidently a composite species. He said (l.c., 113): "As I have not seen the specimen collected by Steller (In Camtschtca et insulis Curilis) mentioned in the original diagnoses of *P. amoena*, I do not know whether Steven included our plant in his very heterogeneous *P. amoena*. It seems to me that the material now passing as *P. amoena* in Siberia should be divided into at least two different species. In the Altai specimens, for instance, the filaments of the two lower stamens are hairy at the base (and are so described by Krylof in Fl. Altaja IV p. 965), whereas they are described as glabrous in the diagnosis of *P. amoena*, and are actually glabrous in the arctic plant, which agrees with the specimen of the plant from lower Lena R. in Herb. Adams, which I have seen in Moscow, and which represents *P. amoena* Adams *sensu stricto*." He gave (l.c., fig. 2) drawings of upper and lower bracts of both *P. eriophora* from Kamchatka and *P. amoena* from Balaganach, lower Lena River.

Hultén, although recognizing *P. eriophora*, admitted "that the line of demarcation between *P. eriophora* and *P. amoena* is not yet fully clear." Both geographically and structurally the plant of the Altai region and northern Mongolia seems different from the typical form of *P. amoena* from arctic Siberia. Unfortunately no specimen from arctic Siberia is available for the present study. It seems that the Altai plant is taller (also noticed by Maximowicz, in Bull. Acad. St. Pétersb., 24: 63, 1878; in Mél. Biol., 10: 97, 1878), and, as Hultén pointed out, the posterior filaments are slightly hairy at base. The southern plant has the upper bracts strongly trifid and the lower ones distinctly pinnatisect. According to Hultén's interpretation of the bracts of the arctic *P. amoena* as illustrated by him, the lower ones are lanceolate and pinnatifid and the upper ones ovate-oblong and entire; these are very different from the Altai plant. Unquestionably two different species are represented. It is hoped that the typical *P. amoena* Adams of arctic Siberia can eventually be fully redescribed, so that related species can be more clearly distinguished from it.

53. **Pedicularis yargongensis** Bonati

Pedicularis yargongensis Bonati, in Bull. Soc. Bot. France, 55: 312, 1908; Limpricht, in Repert. Sp. Nov., 20: 207, 1924. Bonati's type, "Yargong (*R. P. Soulié*), n° 3362, 1903," has not been seen.

In Yargong, Sikang Province. Known from the original collection only. No specimen seen.

According to the description, this species appears to be related to *P. kansuensis*, which has the same type of uncleft calyx. It is apparently not related to *P. rupicola*, as suggested by Bonati and followed by Limpricht, as the latter has cleft calyx. Bonati also recognized the following variety.

53a. **Pedicularis yargongensis longibracteata** Bonati

Pedicularis yargongensis var. *longibracteata* Bonati, in Bull. Soc. Bot. France, 55: 312, 1908; Limpricht, in Repert. Sp. Nov., 20: 207, 1924. Bonati's type, "Yargong (*R. P. Soulié*), n° 3359, 1903," has not been seen.

This variety, according to the description, differs from the typical form of the species in the longer bracts and larger leaves.[17]

54. **Pedicularis dolichostachya** sp. nov. Plate 18, fig. 41.

Planta 2 dm. vel ultra alta; caulibus singulis, simplicibus, erectis, leviter pubescentibus vel glabrescentibus; foliis caulinis 4-verticillatis, inferioribus ignotis, superioribus circiter 3 cm. longis, breviter petiolatis, petiolis 3-4 mm. longis, villosis, laminis ovato-oblongis vel lineari-oblongis, circiter 2.8 cm. longis, 1 cm. latis, sparse hirsutis, pinnatifidis (ex margine ½ ad costam incisis), apice obtusis, basi cordatis, segmentis utrinsecus 6-8, approximatis, ovatis, 2-4 mm. latis, acutis, margine subintegris; inflorescentiis longe terminalibus, circiter 12 cm. vel ultra longis, floribus inferioribus laxis, superioribus multis, compactis; bracteis foliaceis, pinnatifidis, calycem subaequantibus; pedicellis 1-3 mm. longis, erectis; calyce late ovoideo, 5-6 mm. longo, membranaceo, vix reticulato, externe sparsissime hirsuto, antice vix fisso, margine 5-dentato, dentibus subaequalibus vel inaequalibus, deltoideis, acutis, subintegris, margine sparse ciliatis; corollā purpureā, circiter 1.3 cm. longā: tubo 7-8 mm. longo, in calyce subcurvato, supra calycem deflexo, superne dilatato; galeā circiter 5 mm. longā, paulo curvatā, fronte rotundatā, apice acutā, integrā; labio inferiore galeam paulo longiore, 3-lobato, margine sparse ciliato, lobis rotundatis, lobo medio sat parvo, porrecto; staminibus ad basim tubi insertis, antheris glabris, loculis basi acutis, filamentis glabris; stylo haud exserto; capsulis ½ calyce exsertis, oblongis, acuminatis, circiter 1.8 cm. longis, 4-5 mm. latis, valde compressis.

Type, in grassland at an altitude of 3660 meters, Liang-ho-kou, Sikang Province, collected in flower, Aug. 1938, by T. K. Wang and T. S. Wen, No. 648; holotype in the herbarium of the Arnold Arboretum. Flowers purple. Only collection seen.

In the general floral structure, this species is near *P. szetschuanica*. However, its much longer inflorescences and ciliate-margined lower lip differentiate it from the latter as well as from other allied species. The linear-oblong, pinnatifid, sparsely hairy leaves are also distinct. Only a portion of the stem is represented in the type specimen, the roots and lower leaves not being available.

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[17] As it occurs at the same locality, I suspect that this is vegetatively, rather than genetically, differentiated from *P. yargongensis*. F. W. P.

55. Pedicularis flaccida Prain

Pedicularis flaccida Prain, in Journ. Asiat. Soc. Beng., 62 (2): 8, pl. 2, 1893; in Kew Bull., 1893: 157, 1893; Franch., in Bull. Soc. Bot. France, 47: 33, 1900; Limpricht, in Repert. Sp. Nov., 20: 204, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 211, 1934. Prain's type, "Szechuan occident, prope Tachienlu, *Pratt* n. 471!," has not been seen.

In Sikang, near Kanting. Also recorded from Szechuan (ex Pai, l.c.). No specimen seen.

Prain described this plant with the remark that "This is . . . closely related to *P. verticillata* Linn. but differs considerably in habit, and though it has the calyx tube ribbed and not reticulated just as *P. verticillata* has, it differs in having the calyx distinctly toothed and extremely small. The stamens also differ in being all glabrous whereas in *P. verticillata* the anterior pair are hirsute; the anthers though muticuous as in *P. verticillata* are contiguous and not discrete." These characters, in my opinion, show that the plant is only remotely related to *P. verticillata.* Its manner of branching does not suggest close relationship with other species bearing flowers of similar form. Pai (l.c.) credited *Yü* 2036, from Pao-shing District, Szechuan, to this species.

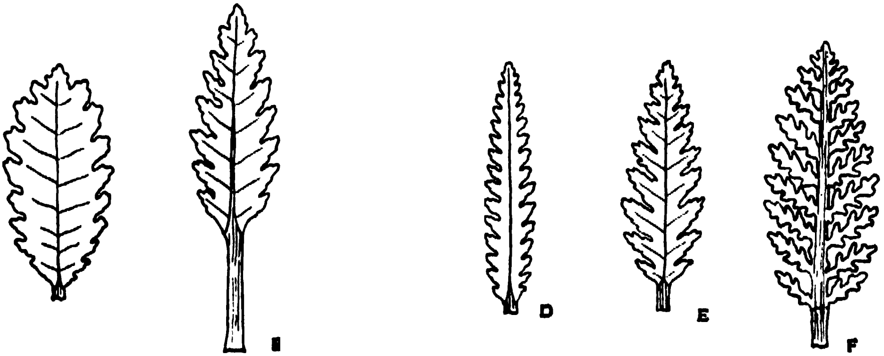
56. Pedicularis szetschuanica Maximowicz

Pedicularis szetschuanica has been regarded by most authors as a very variable species, but in reality, it has never been clearly defined. Maximowicz's original description applies to a composite species that comprised at least three different elements, as will be discussed in detail below. Bonati named three varieties under this species, *elata, angustifolia,* and *longispica:* the first, identical with *P. spicata* var. *australis* Bonati, has been raised into a distinct species, *P. holocalyx* Hand.-Maz.; the second is now continued as a valid variety of the species; and the third, a *nomen nudum* first published by Limpricht, proves to be composite, its several components being all different from this species.

Of the plants that have been referred to *P. szetschuanica* and *P. szetschuanica* var. *longispica,* the dissected-leaved form is found to belong to *P. kansuensis.* Among the others, two groups are distinguishable with regard to their floral characters. One has the calyx not cleft anteriorly but with 5 equal or subequal, conspicuous, and more or less dentate teeth, and has the staminal filaments all glabrous or with one pair slightly hairy. Some plants with wholly glabrous filaments are here referred to the typical form of *P. szetschuanica;* these have broad ovate-oblong leaves that are long-petioled and shallowly pinnately lobed, the lobes 6 to 8, rarely 10, on each side, the incisions between lobes being cut to less than one-half their distance to the midrib. Another group of plants has the calyx deeply cleft anteriorly, but otherwise entire or very inconspicuously dentate, and in it two of the staminal filaments are hairy. These have either deeply 10-15-pinnately lobed or pinnatisect leaves. They not only are different from *P. szetschuanica*, but represent within themselves two different species, now being described as *P. calosantha* and *P. sikangensis*.

As here interpreted, the typical form of *P. szetschuanica* is a plant of western and southern Kansu and Chinghai, and northern Szechuan, with fairly soft-hirsute habit, edentate galea as represented by the middle figure of Maximowicz's original illustration, exserted stigma, more or less conspicuously lobed calyx with the lobes entire or slightly dentate, long-petiolate ovate-oblong leaves that are sometimes cordate at base and pinnately lobed to less than one-half the distance to the midrib, the lobes 6 to 8, rarely to 10, on each side. Two varieties are here recognized as differentiated by the following key.

In addition to the drawings of the flowers, an illustration is here given to show the general outlines of the cauline leaves of the various varieties of *P. szetschuanica*, as well as those of related species. (Text-figure 2.)



Text-figure 2.—Leaves of *Pedicularis szetschuanica* Maxim. and related species. A, *P. szetschuanica* Maxim. var. *ovatifolia* var. nov. B, *P. szetschuanica* Maxim. *typica*. C, *P. szetschuanica* Maxim. var. *angustifolia* Bonati. D, *P. bonatiana* sp. nov. E, *P. calosantha* sp. nov. F, *P. kansuensis* Maxim.

Key to the Varieties

A. Plants hirsute; cauline leaf-blades ovate-oblong to oblong-lanceolate, pinnately lobed, 3 or more times as long as broad, more or less distinctly petiolate; stigmas slightly exserted.

  B. Cauline leaves about 5-10 mm. broad, pinnately lobed to less than one-half the distance to the midrib, the lobes 6 to 8, rarely to 10, on each side, rounded, as long as broad, subentire or crenately or acutely dentate; petioles long, one-half or more the length of the blade. .... 56a. *P. s. typica*

  BB. Cauline leaves about 3-5 mm. broad, pinnately lobed to slightly over one-half the distance to the midrib, the lobes 8-10 on each side, oblong, subentire or obscurely dentate; petioles less than one-half the length of the blade. .... 56b. *P. s. angustifolia*

AA. Plants more or less glabrate; cauline leaf-blades ovate, about 1.4 cm. broad, more or less shallowly pinnately lobed, about twice as long as broad, sessile to subsessile; stigmas included. .... 56c. *P. s. ovatifolia*

56a. Pedicularis szetschuanica typica Plate 18, fig. 42.

Pedicularis szetschuanica Maxim., in Bull. Acad. St. Pétersb., 32: 601, fig. 125, 1888; in Mél. Biol., 12: 892, fig. 125, 1888, p.p.; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 217, 1890, p.p.; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; in Repert. Sp. Nov., 20: 205, 1924, p.p.;[18] Marquand, in Journ. Linn. Soc. Bot., 48: 214, 1929; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933, p.p.; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 221, 1934; Hand.-Maz., Symb. Sin., 7: 849, 1936. Maximowicz's types were from "Prov. *Kansu* orientali et *Szetschuan* boreali multis locis alpinis (Potanin, 1885)." Apparently a series of separate collections from widely scattered localities is represented. The species as described originally by Maximowicz is composite, containing at least three elements as shown by his citation of specimens and the three figures he gave. The figure at left, with conspicuous teeth on the galea, is ruled out by his key alluding to such teeth as "rarius." The right-hand figure, with short calyx-lobes, and with included style, is apparently referable to a specimen in the Bonati Herbarium, *Potanin* s.n.; "Kansu orient. In monte Tschagola, 11 VII 1885," in Maximowicz's handwriting determined as *P. szetschuanica*. It is essentially a glabrate plant with relatively broad, ovate, shallowly pinnately lobed leaves. The cauline leaves are more or less sessile. As the leaves of the species were originally described as pinnately lobed and more or less long-petiolate, both in the description and the key, I take as the typical form of the species the middle figure representing a plant with conspicuously pinnately lobed, more or less long-petiolate leaves, distinct but rounded calyx-lobes, and edentate galea with exserted styles. The Potanin plant mentioned above is therefore not typical but apparently also of this same species and is here made into a distinct variety. However, my interpretation concerning the limits of the species has to be tentative until confirmed by a review of Potanin's specimens in Russia.

"*Pedicularis verticillata*" *sensu* Franch., in Nouv. Arch. Mus. Hist. Nat. Paris II, 10: 68, 1888 (Pl. David. I); *non* Linn. Franchet's determination was based on a David specimen, collected in Moupine, Szechuan Province. This synonym was given by Maximowicz.

Hirsute throughout, stem about 1.2-1.5 dm. high, usually branching at the base, not branched above, with a few radical leaves; leaves 3-4-verticillate, ovate-oblong, 1.5-2.5 cm. long, 5-10 mm. wide, the apex obtuse, the base subcordate to cordate, the margins deeply pinnately lobed to slightly less than one-half the distance to the midrib, the lobes 6 to 8, rarely to 10, on each side, rounded, about as long as broad, subentire to crenately dentate or acutely dentate; petioles of the radical leaves to 3.5 cm. long, of the cauline leaves 0.5-1.5 cm. long, winged; calyx about 4 mm. long, hirsute, 5-dentate, the teeth oblong to triangular, subentire to slightly dentate; corolla about 1.4 cm. long, the tube about 8-9 mm. long, the galea about 5-6 mm. long, slightly shorter than the lower lip, the lower lip 3-lobed, the lobes rounded, entire, the mid-anterior only slightly smaller and distad; anther-pairs more or less discrete, all filaments glabrous throughout; styles exserted.

Highest alpine meadows near mountain tops, at altitudes of 4450 to 4550 meters, in southwestern Kansu and northeastern Chinghai and probably also in northern Szechuan. Flowers dark pinkish purple. Flowering in July.

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[18] Among the citations given, the one by Limpricht in 1920 referred *Forrest* 2594 as well as *C. Schneider* 2048, 3472, 3009, all from Yunnan, to this species. In addition, Bonati (in Notes Bot. Gard. Edinb., 5: 91, 1911; and 7: 145, 1912) referred also *Forrest* 2594 to *P. szetschuanica*. The Forrest number is not available but the three Schneider numbers, all available, are found to be *P. rupicola*.

KANSU: T'ao River basin, Mt. Lissedzadza, *Rock* 12620 (ANSP, GH, NYBG, USNH).

CHINGHAI: Amnyi Machen range, Tarung valley, *Rock* 14416 (ANSP, GH); grasslands between Labrang and Yellow River, near summit of Wanchen nira, *Rock*, 14503 (ANSP, GH, NYBG).

56b. **Pedicularis szetschuanica angustifolia** Bonati

Pedicularis szetschuanica Maxim. var. *angustifolia* Bonati, in Bull. Herb. Boiss. II, 7: 545, 1907; Limpricht, in Repert. Sp. Nov., 20: 205, 1924. Bonati's types were from Sikang, "Soulié, n° 568: Ta-Tsien-Lou; n° 714 Tongolo [in herb. Boissier]." Both numbers are found in the Bonati Herbarium; evidently they are isotypes.

Plant 1.2-2.2 dm. tall, slightly hirsute along stems and leaves, more densely so in the inflorescences; stem sometimes branching at base, not branched above, with a few radical leaves; leaves oblong-lanceolate, 1.5-2 cm. long, 3-5 mm. wide, the apex obtuse to acute, the margins deeply pinnately lobed to slightly over half the distance to the midrib, the lobes 8 to 10 on each side, as long as broad or slightly longer, subentire or dentate; petioles of radical leaves to 1.5 cm. long, of cauline leaves 4-6 mm. long, slightly winged; floral characters like the typical form of the species.

SIKANG: Ta-tsien-lou, *Soulié* 568 (ANSP, UCLA); Tongolo, *Soulié* 714 (B), 2873 (ANSP, NYBG).

56c. **Pedicularis szetschuanica ovatifolia** var. nov.

Pedicularis szetschuanica Maxim., in Bull. Acad. St. Pétersb., 32: 601, fig. 125. 1888, p.p.; in Mél. Biol., 12: 892, fig. 125, 1888, p.p. One of the syntypes originally designated by Maximowicz as *P. szetschuanica, Potanin* s.n., from Mt. Tschagola, eastern Kansu, in the Bonati Herbarium, is to pass to the University of California at Los Angeles, with photograph at Academy of Natural Sciences of Philadelphia. The floral structures agree with that illustrated by Maximowicz in the figure at the left. This form, being different from the typical form of the species as here interpreted, is made into a separate variety.

A typo speciei recedit plantā glabratā; foliis ovatis, latis, caulinis circiter 2.5 cm. longis et 1.4 cm. latis, apice late obtusis, basi rotundatis, margine pinnatifidis, lobis utrinsecus 8-10; stylis inclusis.

Plant glabrate, about 2 dm. tall, the stem not branching; leaves ovate, about 2.5 cm. long and 1.4 cm. wide, the apex broadly obtuse, the base rounded, the margins pinnatifid to less than one-half the distance to the midrib, the lobes 8-10-paired, rounded, about as long as broad, dentate; calyx about 4 mm. long, 5-dentate, the teeth oblong to deltoid, subentire; corolla and stamens like that of the typical form of the species; styles included.

Type, in eastern Kansu, Mt. Tschagola, collected in flower, July 11, 1885, by G. N. Potanin, sine num.; holotype in the Bonati Herbarium, to be deposited in the herbarium of the University of California at Los Angeles. Only collection seen.

57. **Pedicularis glabrescens** sp. nov. Plate 18, fig. 43.

Planta perennis, glabrescens, radice subcrassa; caulibus plurimis, erectis, 2-2.5 dm. vel ultra altis, simplicibus; foliis caulinis, 3-4-verticillatis, petiolatis, ad 4.5 cm. longis, petiolis ad 1.5 cm. longis, gracilibus, glabris, laminis ovato-oblongis, circiter 2-3 cm. longis, 1-1.5 cm. latis, pinnatisectis, membranaceis, glabris, segmentis utrinsecus 6-8, approximatis, ovato-oblongis, 3-4 mm. latis, apice obtusis, basi latis, adnatis, margine serratis; inflorescentiis terminalibus, 4.5-13 cm. longis, floribus plus minusve disjunctis; bracteis foliaceis, inferioribus pinnatisectis floribus superantibus, superioribus parvibus pinnatifidis, floribus ½ aequantibus; pedicellis 2-5 mm. longis, erectis, gracilibus, glabris; calyce late ovoideo, circiter 5 mm. longo, membranaceo, glabro, vix reticulato, 5-dentato, dentibus subaequalibus, late ovatis, irregulariter serratis; corollā purpureā, circiter 1.3 cm. longā: tubo 8-9 mm. longo, in calyce subincurvato; galeā plus minusve erectā, circiter 5 mm. longā, fronte rotundatā, apice acutā, margine inferiore integrā; labio inferiore 6 mm. longo, lobis rotundatis, integris, lobo medio parvo, porrecto; staminibus ad basim tubi insertis, filamentis anterioribus superne sparse villosis, antheris contiguis, glabris, loculis basi acutis; stylo incluso; capsulis ignotis.

Type in northwestern Yunnan, field data not available, collected in flower by T. T. Yü, No. 8751; holotype in the herbarium of the Arnold Arboretum. Only collection seen.

In the floral characters this species is more or less close to *P. kansuensis*. However, its glabrescent habit and broad leaf-segments readily distinguish it from the latter. The corolla-color, as apparent in the dry state, is probably purplish.

58. Pedicularis kansuensis Maximowicz Plate 18, fig. 44.

Pedicularis verticillata var. *chinensis* Maxim., in Bull. Acad. St. Pétersb., 24: 63, 1878; in Mél. Biol., 10: 96, 1878. "In Chinae prov. Kansu montosis, vulgaris (Przewalski, Piasezki)." The reduction of this trinomial to the synonymy of *P. kansuensis* was made by Maximowicz himself. In the Bonati Herbarium there is a sheet: "Terra Tangutarum, Prov. Kansu, Przewalski, 1872, 1873," (ex Herb. Petrop.), labelled originally as *P. kansuensis* Maxim. It consists of two specimens. Bonati dissected and studied both and noted that specimen (a) is referable to *P. amoena* Adams, while specimen (b) is truly *P. kansuensis*. It is possible, judging from the dates of collecting, that the second specimen is among the original specimens referred by Maximowicz to *P. verticillata chinensis*. The first, a rather poor specimen, is probably the same as *P. hulteniana* described in this paper.

Pedicularis kansuensis Maxim., in Bull. Acad. St. Pétersb., 27: 516, 1881; 32: 596, fig. 116, 1888; in Mél. Biol., 11: 287, 1881; 12: 886, fig. 116, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 210, 1890; Bonati, in Bull. Herb. Boiss. II, 7: 545, 1907; in Bull. Soc. Bot. France, 54: 186, 1907; Diels, in Futterer, Durch Asien, 3: 21, 1911; Limpricht, in Repert. Sp. Nov. Beih., 12: 185, 1922; Repert. Sp. Nov., 20: 208, 1924; Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 33, 1933; Hand.-Mas., Symb. Sin., 7: 850, 1936; Walker, in Contr. U. S. Nat. Herb., 28: 659, 1941. Maximowicz's type, "E. Kansu alte alpina ad summa fl. Hoangho lectam denuo attulit Przewalski, 1880," has not been seen.

Pedicularis gonantha Bureau & Franch., in Morot, Journ. de Bot., 5: 128, 1891; Bonati, in Bull. Herb. Boiss. II, 7: 545, 1907; Limpricht, in Repert. Sp. Nov., 20: 210, 1924. Bureau and Franchet's type was from, "province de Se-tchuen, entre Ta-tsien-lou et la frontière du Yun-nan [recueillie pendant le voyage de M. Bonvalot et du Prince Henri d'Orleans en 1890] "; it has not been seen. Bonati in 1907 credited *Soulié* 582, 890, and 907 to this species; but later (in Bull. Bot. Soc. France, 57, Mém. 18: 35, 1910) he said: "Le *P. goniantha* Bur. et Ft, dont nous n'avons pu voir d'échantillons authentiques, nous semble devoir être placé à coté du *P. kansu-*

ensis Maxim., dont il diffère par ses fleurs pourpres. Franchet a du reste reconnu lui-même la chose, puisque les échantillons authentiques de *P. gonantha* portent également le nom de *P. kansuensis* Maxim." Limpricht included this species in the series Abrotanifoliae, but said: "Systematische Stellung unsicher."

Pedicularis futtereri Diels ex Futterer, Durch Asien, 3: 20, tab. 3, fig. B, 1911; Limpricht, in Repert. Sp. Nov., 20: 211, 1924. Diel's type, "Küke-nur-Gebiet: Am Nordfuss der Korallenkalkberge des Semenow-gebirges bei Lager XVII. ([*K. Futterer*] n. 157—Blühend, 10. September!)," has not been seen. Diels referred this species to the series Verticillatae and mentioned that it is easily distinguished from other species of the group by its characteristic galea which is crested and crenately denticulate. Limpricht referred it to the Cheilanthifoliae, which is evidently not correct. The original description and the excellent plate show clearly that this species is identical with *P. kansuensis*, the crenately denticulate character of the galea being frequently present in the latter species. It seems to be quite safe to reduce this species to the synonymy of *P. kansuensis*.

Pedicularis tangutica Bonati, in Bull. Soc. Bot. Genève II, 4: 328, 1912; Limpricht, in Repert. Sp. Nov., 20: 204, 1924. Bonati's type, "Kan-Sou, region de Tangut (Przewalski, 1880)," in the Edinburgh Herbarium, has been seen. A photograph is also in the herbarium of the Academy of Natural Sciences of Philadelphia. The specimen is in poor condition, but it undoubtedly pertains to *P. kansuensis;* apparently it is part of the same collection of Przewalski, from Kansu in 1880, that supplied the type of *P. verticillata* var. *chinensis* Maxim., the variety later reduced by Maximowicz himself to the synonymy of *P. kansuensis*.

Pedicularis szetchuanica Maxim. var. *longispica* Bonati ex Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922, *nomen nudum;* Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933, p.p. *Rock* 14192, cited by Rehder & Kobuski, belongs to *P. kansuensis*.

"*Pedicularis szetschuanica*" *sensu* Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933, p.p., *non* Maxim. *Rock* 14191, cited by Rehder and Kobuski, is found to be a specimen of *P. kansuensis*.

Grassy slopes or ravines at altitudes of 1825 to 3850 meters in southwestern Kansu, Chinghai, and Sikang. Flowers purple-pink to purple-red. Flowering from June through August.

KANSU: Tangut region, *Przewalski* s.n. (p.p., RBGE, UCLA); T'ao River basin, Choni, *Rock* 12287 (ANSP, CM, GH, UC); T'ao River basin, beyond Poyu, *Rock* 12794 (ANSP, NYBG); Yao kai, near Lichen, *Ching* 280 (ANSP, GH, UC, USNH); Datung, *Farrer* 714 (RBGE).

CHINGHAI: Radja and Yellow River gorges, east of Radja, *Rock* 14118 (ANSP, GH); Radja and Yellow River gorges, southeast of Radja, *Rock* 14192 (ANSP, GH, NYBG); Radja and Yellow River gorges below Lungmen Valley along Yellow River, southeast of Radja, *Rock* 14208 (ANSP, USNH); Ba Valley, banks of Ba streams, *Rock* 14270 (ANSP, GH, NYBG).

SIKANG: mountains between the Litang and Shou-chu Rivers, between Wa-Erh-Dje and Garu, *Rock* 16763 (ANSP, USNH); Baurong to Tachienlu, via Hadjaha, *Stevens* 309 (ANSP, CM, USNH), 313 (CM), 530 (ANSP, CM).

The various specimens show that the inflorescences may be very long-spicate with the flowers more or less disjunct in the axils of the leaves or bracts or short-spicate with the flowers more or less compactly arranged. The galea, not described by Maximowicz, is found to be crested at the apex and either entire or very distinctly crenate-denticulate. This character, which has been emphasized by Diels, is, as here observed, quite commonly present in *P. kansuensis*, but nevertheless, not entirely constant. Diels described all of the filaments as being hairy; in the specimens examined it is found that, as originally described by Maximowicz, only the anterior ones are hairy, while the posterior ones are glabrous but occasionally sparsely hairy.

58a. Pedicularis kansuensis, forma albiflora f. nov.

A typo speciei differt floribus albidis.

Type, Nerechu River, Tschan-la, Sikang Province, collected in flower, July 26, 1885, by G. N. Potanin, sine num.; holotype in the Bonati Herbarium to be deposited in the Herbarium of the University of California at Los Angeles.

Moist steppes, at altitudes of 3000 to 4000 meters in southern Kansu and Sikang. Flowers white. Flowering in July and August.

KANSU: Ni Mar Lan Kou, en route to Labrang, *Ching* 743 (ANSP, USNH); Radja and Yellow River gorges, southeast of Radja, *Rock* 14191 (GH).

SIKANG: Nerechu River, Tschan-la, *Potanin* s.n. (UCLA); Ta-tsien-lou, *Soulié* 907 (B), 976 (ANSP, B); Minya Konka Snow Range, east of Yulong Hsi, *Rock* 17610 (ANSP, USNH).

59. Pedicularis tenera sp. nov. Plate 18, fig. 45.

Perennis, radice subcrassā; caulibus plurimis vel singulis, erectis, valde brevibus vix ad 7 cm. longis, simplicibus, leviter puberulis; foliis 3- vel 4-verticillatis, radicalibus paucis, evanidis, longe petiolatis (petiolis ad 1.5 cm. longis), caulinis petiolatis (petiolis ad 1 cm. longis, alatis, interdum ad basim dilatatis haud confluentibus), glabris levissime ciliatis, oblongo-ovatis, acutis, circiter 1-1.5 cm. longis, 4-6 mm. latis, pinnatisectis vel pinnatifidis dentatisque; inflorescentiis laxis terminalibus, 1-2.5 cm. longis; bracteis foliaceis pinnatisectis ciliatis, basi saepe dilatatis; floribus subsessilibus; calycis tubo circiter 3 mm. longo, sparse ciliato, 10-costato, 5-dentato, dentibus subaequalibus, oblongis, circiter 2 mm. longis, basim versus leviter angustatis, superne dentatis; corollā omnino glabrā purpureā, circiter 1.5 cm. longā: tubo 9-10 mm. longo, in calyce incurvato; galeā plus minusve erectā, circiter 5-6 mm. longā, fronte rotundatā, apice inferiore acutā, margine inferiore integrā; labio inferiore 6-7 mm. longo, lobis rotundatis integris, lobo medio parvo porrecto prominulo; staminibus basim tubi insertis, filamentis 2 superne sparse hirsutis, antheris discretis, glabris, loculis basi obtusis; capsulis (immaturis) ovoideis glabris subnitidis, abrupte acutis, 5-6 mm. longis, 3-5 mm. latis.

Type, on screes of limestone mountains, at an altitude of about 4600 meters, in the Muli Territory, mountains between the Litang and Yalung Rivers, between Mula Gomba and Baurong and Wa-Erh-Dje, in Sikang Province, collected in flower, July 1928, by J. F. Rock, No. 16710; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium. Flowers purple. Only collection seen.

This species resembles *P. rupicola* in general appearance but is distinct from the latter in the plant being much smaller, the calyx not cleft anteriorly, and with longer and narrower calyx-lobes, and 2 filaments being sparsely hairy. It is possibly most closely related to *P. roylei* and *P. daucifolia* (ex description), but besides being a smaller plant, it differs from these two in the hairiness of the 2 anterior filaments.

60. **Pedicularis daucifolia** Bonati

Pedicularis daucifolia Bonati, in Bull. Soc. Bot. France, 55: 313, 1908; Limpricht, in Repert. Sp. Nov., 20: 205, 1924. Bonati's type, "Yargong (*R. P. Soulié*), n° 3759, 1904," is in the Paris Museum. No type material has been seen.

In Yargong, Sikang Province. Known from the original collection only. No specimen seen.

According to Bonati, this species is near *P. szetschuanica*. The latter species, as originally described by Maximowicz, is so composite that comparison with it does not indicate relationship. From the description, this species appears to resemble *P. rupicola*, though it differs in the calyx not being cleft anteriorly.

61. **Pedicularis roylei** Maximowicz Plate 18, fig. 46.

Pedicularis roylei Maxim., in Bull. Acad. St. Pétersb., 27: 517, 1881; 32: 597, fig. 122, 1888; in Mél. Biol., 11: 288, 1881; 12: 891, fig. 122, 1888; Bonati, in Bull. Soc. Bot. France, 54: 186. 1907; Limpricht, in Repert. Sp. Nov., 20: 207, 1924; Marquand, in Journ. Linn. Soc. Bot., 48: 213, 1929; Hand.-Maz., Symb. Sin., 7: 850, 1936. Maximowicz's types, "Himalaya occidentali (Royle!), Tibeto occidentali ad Tschangra (Heide!)," have not been seen. A study of authentically named specimens from Tibet and the original description and illustration of Maximowicz shows that the western Chinese plants have been correctly referred to this Himalayan and western Tibetan species by Bonati, Handel-Mazzetti, etc.

"*Pedicularis amoena*" *sensu* Maxim., in Bull. Acad. St. Pétersb., 24: 63, 1878; in Mél. Biol., 10: 97, 1878, p.p., *non* Adams. The western Himalayan specimens credited by Maximowicz to *P. amoena* were subsequently made into the types of *P. roylei* by him.

On grassy slopes at altitudes of 4100 to 4500 meters, from northwestern Yunnan and Sikang along the Himalaya to Hazara[19] and western Tibet. Flowers pink, purple, to red. Flowering from July to September.

WESTERN CHINA: no locality, *Wilson* 4256 (UCLA).

YUNNAN: between Likiang and Young-ning, *Rock* 17330 p.p. (USNH).

SIKANG: Muli, Mt. Saganai, *Handel-Mazzetti* 7334 (GH, USNH); Minya Country, grasslands of Yulong Hsi. south of Tatsienlu, *Rock* 17480 (ANSP, USNH); Glacial Lake, *Ward* 4697 (RBGE); Mu-li, *Ward* 4734 (RBGE).

TIBET: Phari, *Dungboo* s.n. (Calcutta); Chumbi valley, Chakalung La, *R. Lepcha* 335 (ANSP); Chumbi Valley, Chumolari, *R. Lepcha* 488 (ANSP).

This species resembles *P. rupicola* in general appearance. But besides the difference in geographical distribution it is a lower plant that is more or less densely branched at base. Its flowers are smaller, the calyx is not cleft anteriorly, and the tube of the corolla is nearly straight in the calyx-tube. In *P. rupicola* the calyx is distinctly cleft anteriorly, and the corolla-tube strongly deflexed in the calyx-tube so that it protrudes laterally from the anterior cleft.

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[19] For citations of specimens from the western Himalayas, as well as confirmation of the type collection, see Pennell in Monogr. Acad. Nat. Sci. Phila., 5: 119-120, 1943.

Among the specimens cited above, *R. Lepcha* 488 is possibly *P. roylei* Maxim. subvar. *speciosa* Prain, in Ann. Bot. Gard. Calcutta, 3: 173, p. 33, C, 1891; with flowers somewhat larger than the type and bracts longer petiolate.

61a. Pedicularis roylei cinerascens Marquand & Shaw

Pedicularis roylei Maxim. var. *cinerascens* Marquand & Shaw ex Marquand, in Journ. Linn. Soc. Bot., 48: 213, 1929. "S.E. Tibet. Flowers purple with the upper lip darker. On alpine slopes among dwarf *Rhododendron*. Nyima La, 4500 m., June 21, 1924. *F. Kingdon Ward* 5814."

Sikang. Flowers purple with darker upper lip. Known from the original collection only. No specimen seen.

Differs from the typical form of the species in the leaves being cinereo-pubescent.

62. Pedicularis verticillata Linnaeus

This species, widely distributed over the colder parts of the northern hemisphere, is remarkably uniform. The Asiatic plants extend farther south than those in Europe and North America, and they also occur at higher altitudes. A variety with broadly pinnatifid leaves, recognized by Hultén in Kamchatka, is found to be represented also by a specimen from Shansi, China. It may be that this variety occurs also in intervening localities.

Key to Varieties

A. Leaves about 1-1.2 cm. broad, more deeply pinnatifid, the segments narrow, about 1-2 mm. wide, oblong. .... 62a. *P. v. typica*

AA. Leaves about 1.2-1.8 cm. broad, less deeply pinnatifid, the segments broad, ovate, about 3-4 mm. wide. .... 62b. *P. v. latisecta*

62a. Pedicularis verticillata typica

Plate 18, fig. 47.

Pedicularis verticillata Linn., Sp. Pl. 608, 1753; Benth., in D.C., Prodr., 10: 563, 1846; Maxim., in Bull. Acad. St. Pétersb., 24: 62, 1878; 32: 600, fig. 123, 1888; in Mél. Biol., 10: 95, 1878; 12: 891, fig. 123, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 219, 1890; Diels, in Bot. Jahrb., 29: 572, 1900; Komarov, in Act. Hort. Petrop., 25: 457, 1907; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; in Repert. Sp. Nov., 20: 203, 1924; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 224, 1934; Hand.-Mas., Symb. Sin., 7: 849, 1936. Linnaeus' types: "Habitat in Sibiria, Helvetia, Austria."

A species widely distributed in the colder regions of the northern hemisphere, in arctic highlands, northern Eurasia, and northwestern North America. In China it is found in Mongolia, Manchuria, Shansi, and Hopei, on mountain tops and alpine meadows, at altitudes of about 2100 to 3350 meters. Flowers pink. Flowering in July and August.

MONGOLIA: east of Dojen, *Eriksson* 40 (USNH); northern Mongolia and Khangai, *Ikonnikov-Galitsky* 324 (NYBG, UC); montes Kentei ad fontes fluviorum Tola, *Ikonnikov-Galitsky* 2806 p.p. (NYBG), 3491 (UC).

HOPEI: Hsiao Wutaishan, *C. F. Li* 11010 (NYBG), *T. P. Wang* 602 (NYBG).

SHANSI: Mt. Wu-tai, *Tang* 1125 p.p. (ANSP).[20]

62b. Pedicularis verticillata latisecta Hultén

Pedicularis verticillata Linn. var. *latisecta* Hultén, in Svensk. Vet. Akad. Handl., III, 8^2: 125, 1930. Hultén, in listing specimens of *P. verticillata* from Kamchatka said under that species: "As already pointed out by Maximowicz (Bull. Ac. Imp. Sc. St. Petersb. 32 (1888) p. 600), most Asiatic specimens are higher-grown than the European. Otherwise they agree fairly well. Some of our specimens, however, differ not only in being usually high-grown but also in having pinnatifid leaves, large pinnatifid bracts, long internodes and the whorls (at least the lowest) very distant from each other. In habit this form very closely resembles *P. refracta* Maxim. in Bull. Acad. Petrop. XXVII (1880) p. 517, but in the veins of the calyx, the length of the filaments and its upward-turned capsules, it agrees with *P. verticillata* and not with that species. It might be regarded as a separate variety var. *latisecta*." He did not give a formal description of the variety and indicated only the following specimens, listed together with other specimens under *P. verticillata*, as of var. *latisecta: Hultén* 325, 3528, *W. Eyerdam*, s.n., *R. Komarov*, s.n. A specimen of *W. Eyerdam* is in the herbarium of the New York Botanical Garden. The specimen referred below to this variety differs from the Kamchatka plant in that it is shorter and is more hirsute, otherwise it agrees closely in the characteristically broad-pinnatifid leaves and bracts, and is undoubtedly of this same variety.

SHANSI: Mt. Wu-tai, *Tang* 1125 p.p. (NYBG). (See footnote under *Tang* 1125 of *P. verticillata typica*.)

63. Pedicularis sikangensis sp. nov. Plate 18, fig. 48.

Biennis vel perennis (?), radice parvā subcrassā; caulibus pluribus simplicibus gracilibus glabris vel valde leviter pubescentibus, 2-3-nodis; foliis basalibus longe petiolatis (petiolis 1.5-2 cm. longis, gracilibus), caulinis 4-verticillatis, petiolatis (petiolis 3-5 mm. longis, leviter alatis), ovato-oblongis, ad 2.5 cm. longis et 1.6 cm. latis, utrinque glabris vel valde sparse hirsutis, apice obtuse acutis, pinnatisectis, rhachidibus alatis, 1-1.5 mm. latis, segmentis utrinsecus 6 vel 7, late oblongis, ad 6 mm. longis et 3 mm. latis, leviter pinnatifidis vel dentatis; inflorescentiis spicatis terminalibus 2-5 cm. longis, glabris vel leviter ciliatis, fasciculis superioribus aggregatis inferioribus discretis; pedicellis 2-3 mm. longis; bracteis inferioribus foliaceis pinnatisectis superioribus oblongo-lanceolatis, calycem duplo superante, pinnatifidis vel subintegris, leviter ciliatis; calyce late ovato, 5-6 mm. longo, membranaceo, 10-costato glabro vel ad marginem sparse ciliato, antice fisso, integro vel inconspicue 2-dentato; corollā purpureā, circiter 1.5 cm. longā, omnino glabrā: tubo in calyce incurvato, deflexo, superne dilatato, circiter 8-9 mm. longo; galeā circiter 5.5 mm. longā et 2 mm. latā, fronte plus minusve rotundatā, apice acute truncatā, margine inferiore integrā; labio inferiore circiter 6-7 mm. longo, venis reticulatis pallide atro-purpureis, lobis rotundatis integris, lobo medio subtruncato parvo porrecto; staminibus ad basim tubi insertis, filamentis anterioribus superne pilosis, antheris discretis, loculis basi acutis; capsulis oblongis acutis, ad 1.6 cm. longis et 4 mm. latis, in sicco atro-brunneis, divaricatis.

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[20] The specimen bearing the number *Tang 1125* in the herbarium of the New York Botanical Garden is *P. verticillata* var. *latisecta*. It is mounted on the same sheet with *C. F. Li* 11010 from Hopei, a typical form of *P. verticillata*. The same *Tang 1125* in the herbarium of the Academy of Natural Sciences of Philadelphia, however, is a typical form of *P. verticillata*. The New York specimen bears the original tag of the collector and is clearly the correct number. The Philadelphia specimen may be from the same locality or may be of some other collection.

Type, in alpine meadows, Mount Mitzuga, west of Muli Gomba, Muli Territory, Sikang Province, at an altitude of 4450 meters, collected in flower, June 1928, by J. F. Rock, No. 16540; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium.

Alpine meadows, at altitudes of 3800 to 4450 meters, in southeastern Sikang, and northwestern Yunnan (?). Flowers purple. Flowering from May to July.

SIKANG: Muli Territory, Mount Mitsuga, west of Muli Gomba, *Rock* 16540 (ANSP, USNH); Kaushu Shan on trail to Leirong, southwest of Muli, *Rock* 24109 (CM, MBG, NYBG, UC, UP, USNH).

YUNNAN: no data, *Yü* 7406 (AA).

This is another species of the alliance of *P. verticillata,* and is particularly close to *P. calosantha* described below. With the latter species it agrees in the more or less glabrous habit, pinnatisect leaves, anteriorly cleft calyx that is otherwise entire or obscurely two-toothed, corolla with more or less dark veins on the lower lip, and hairy anterior filaments. It differs in the stems being frequently many and equal in height, the leaves being wider and with broader segments, the bracts being longer, and the galea with slightly more acute apex. It is also farther south in distribution and represents the southernmost species of the group close to *P. verticillata.*

64. **Pedicularis calosantha** sp. nov. Plate 18, fig. 49.

Pedicularis szetschuanica Maxim. var. *longispica* Bonati ex Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; in Repert. Sp. Nov., 20: 205, 1924, *nom. nud.;* Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933, *nom. nud.* p.p. *quoad specimina citata.* Limpricht gave in 1922, "var. *longispica* Bonati in Sched.—Ost.-Tibet: Hor Tschango, Schtiala, 3650 m (n. 2093).," and in 1924: "Var. longispica Bonati in herb. Berol.," citing at the same time the following specimens: *Soulié* 2058, 2059, 2060, 2873, 2873b, 2875, 2834, *Limpricht* 2093. These specimens are not available. Rehder & Kobuski cited *Rock* 12643, 14192, 14415. The first and last numbers are here referred to this new species, while the middle number is identified as *P. kansuensis.*

"*Pedicularis szetschuanica*" *sensu* Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933, p.p., *non* Maxim. *Rock* 14161, cited as representing *P. szetschuanica* Maxim. by Rehder & Kobuski, is here determined as belonging to this new species.

Perennis (?), radice parvā subcrassā; caulibus singulis vel ad basim pauci breviter ramosis, aliis simplicibus, glabris vel plerumque paulo pubescentibus, 15-23 cm. altis, circiter 3-4-nodis; foliis 3-5, plerumque 4-verticillatis, basalibus longe petiolatis (petiolis 1-1.5 cm. longis), superioribus breviter petiolatis (petiolis 2-10 mm. longis), ovato-oblongis, ad 2.5 cm. longis et 1.3 cm. latis, plus minusve membranaceis, glabris vel vix hirsutis, profunde pinnatifidis vel pinnatisectis, rhachidibus alatis, 1-2 mm. latis, segmentis utrinsecus 8, ovato-oblongis, ad 6 mm. longis et 2 mm. latis, leviter pinnatifidis vel dentatis; inflorescentiis spicatis terminalibus, 1.5-3.5 cm. longis, subglabris vel vix hirsutis; bracteis inferioribus foliaceis, superioribus oblongo-lanceolatis pinnatifidis vel dentatis; pedicellis 1.2 mm. longis; calyce late ovato obliquo, circiter 4-5 mm. longo, membranaceo, 10-costato, glabro vel ad apicem parce ciliato, antice fisso, integro vel obscure 2-dentato; corollā purpureā, circiter 1.5 cm. longā, omnino glabrā: tubo in calyce incurvato, deflexo, superne dilatato, circiter 8-9 mm. longo; galeā circiter 5.5 mm. longā et 2.5 mm. latā, fronte plus minusve rotundatā, apice truncatā, margine inferiore integrā; labio inferiore circiter 6-7 mm. longo, venis reticulatis atro-purpureis, lobis rotundatis, integris, lobo medio leviter truncato, parvo, porrecto; staminibus ad basim tubi insertis, filamentis anterioribus parce pilosis, antheris discretis, loculis basi acutis; capsulis ignotis.

Type, in alpine meadows west of Adjuan, T'ao River basin, in southwestern Kansu, at an altitude of 3880 meters, collected in flower, July 1925, by J. F. Rock, No. 12643; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotypes in the herbarium of the New York Botanical Garden and the Gray Herbarium.

Alpine meadows, at altitudes of 3550 to 4400 meters, in southwestern Kansu and eastern Chinghai. Flowers pink to purplish pink. Flowering in July and August.

West China: no locality, *Wilson* 4251 (ANSP), 4251A (UCLA), 4263 (UCLA).

Kansu: T'ao River basin, Adjuan, *Rock* 12643 (ANSP, GH, NYBG).

Chinghai: between Radja and Jupar Range, Wajo la, *Rock* 14161 (ANSP, CM, GH, UC); Amnyi Machen Range, Tarang Valley, *Rock* 14415 (ANSP, GH).

A species characterized by the more or less glabrous habit, deeply pinnatifid to pinnatisect leaves, the anteriorly cleft and otherwise subentire to obscurely 2-dentate calyx, and the lower lip of the corolla provided with showy dark purplish veins.

This species, together with the next, *P. bonatiana*, were previously confused with *P. szetschuanica*. From the latter species, as more precisely defined in this work, these two species differ notably in the more deeply divided leaves and in the anteriorly cleft calyces. They are more closely related to *P. verticillata* than to *P. szetschuanica*. But, besides the difference in habit, they can be distinguished from *P. verticillata* by the presence of 2 hairy filaments and the smaller, more inconspicuous, calyx-teeth. *P. chingii* is also allied to these species, but it is distinguished by its somewhat woody stems which are freely branched above, and its laxly and distantly arranged flowers.

65. Pedicularis bonatiana sp. nov. Plate 19, fig. 50.

"*Pedicularis szetschuanica*" *sensu* Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 34, 1933, p.p., *non* Maxim.

Perennis, radice parvā crassā; caulibus singulis vel ad basim multis longe ramosis, aliter simplicibus, plus minusve totis hirsutis, 12-25 interdum ad 45 cm. altis, circiter 3-4-nodis; foliis 3-4-verticillatis, radicalibus numerosis longe petiolatis (petiolis 1.5-2 cm. longis, hirsutis), caulinis petiolatis (petiolis 3-15 mm. longis, hirsutis), oblongo-lanceolatis, obtusis, utrinque hirsutis, 2-5 cm. longis, 0.5-1.5 cm. latis, pinnatisectis, segmentis utrinsecus 10-12, ovatis rotundatis dentatis; inflorescentiis spicatis terminalibus, 3-4.5 cm. longis, fasciculis inferioribus paulo disjunctis, superioribus compactis, hirsutis; bracteis inferioribus foliaceis, superioribus oblongo-lanceolatis, basi dilatatis, subintegris vel serratis; pedicellis 2-3 mm. longis; calyce late ovato leviter obliquo, hirsuto, 5-6 mm. longo, 10-costato, antice fisso, margine minute irregulariter 5-dentato, dentibus subdeltoideis dentatis; corollā purpureā, circiter 1.5 cm. longā, omnino glabrā: tubo 8-9 mm. longo, in calyce incurvato, deflexo, superne recto dilatato; galeā 5.5 mm. longā, fronte rotundatā, apice inferiore leviter protrusā truncatā, margine inferiore integrā; labio inferiore 6-7 mm. longo, lobis rotundatis integris, lobo medio parvo porrecto; staminibus ad basim tubi insertis, filamentis anterioribus superne hirsutis, loculis basi acutis; capsulis ignotis.

Type, along streams, at an altitude of 3020 meters, in Ba Valley, eastern Chinghai, collected in flower, June 1925, by J. F. Rock, No. 14274; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the Gray Herbarium.

KANSU: T'ao River basin, along T'ao River, near Choni, *Rock* 12244 (ANSP, GH, UC).

CHINGHAI: Ba Valley, *Rock* 14252 (ANSP, GH, NYBG, USNH), 14274 (ANSP, GH).

66. Pedicularis chingii Bonati Plate 19, fig. 51.

Pedicularis chingii Bonati, in Arch. Bot. (Caen) Bull., 1: 4, 1927; Limpricht, in Repert. Sp. Nov., 23: 334, 1927; Walker, in Contr. U. S. Nat. Herb., 28: 659, 1941. Bonati's type was from 'Kansuh: Ni Mar Lan K'ou, en route to Labrang; altitude 3.000 à 4.200 meters; fl. purple, woods—Ching n° 761, août 15, 1923.' Isotypes are in the United States National Herbarium and the herbarium of the Academy of Natural Sciences of Philadelphia. These isotypes show that the calyx is strongly cleft in the anterior and the corolla emerges laterally through the cleft. This is not described by Bonati.

In woods, at altitudes of 3000 to 4200 meters, in Kansu. Known from the original collection only. Flowers purple. Flowering in August.

KANSU: Ni Mar Lan K'ou, en route to Labrang, *Ching* 761 (ANSP, USNH).

In the somewhat woody stem, which is freely branched above, this species is distinct and characteristic. Undoubtedly its relationship is with *P. verticillata* as shown by the anteriorly cleft calyx with 5 more or less inconspicuous teeth.

67. Pedicularis rupicola Franchet

This species appears to be a variable one. Variations are found in the length and mode of branching, degree of dissection of the leaves, hairiness of the bracts and calyces, and length and shape of the fruits. These characters are not always sharply marked in the two varieties of the species, but the combined presence of most of these characters will enable one to distinguish them with reasonable certainty.

Key to the Varieties

A. Plant lower, to about 1.5 dm. tall, the branches often strongly divaricate at base, flexuous; inflorescences relatively shorter, to 8 cm. long, the fascicles fewer and more compactly arranged; calyces and bracts more or less densely hirsute; capsules broader and shorter, about 1.8 cm. long and 8 mm. wide, acute. 67a. *P. r. typica*

AA. Plant tall, to 2 dm. or more tall, the branches erect, not divaricate at base, straight; inflorescences more elongated, to 12 cm. long, the fascicles more numerous and more distant below; calyces and bracts usually glabrous except along the margins; capsules longer and narrower, about 2.1 cm. long and 6 mm. wide, long-acuminate. .... 67b. *P. r. zambalensis*

67a. Pedicularis rupicola typica Plate 19, fig. 52.

Pedicularis rupicola Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 599, fig. 121, 1888; in Mél. Biol., 12: 890, fig. 121, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 215, 1890; Limpricht, in Repert. Sp. Nov., 20: 207, 1924; 23: 334, 1937; Staff Bot. Gard. Edinb., in Notes Bot. Gard. Edinb., 17: 68, 1929; Hand.-Maz., Symb. Sin., 7: 850, 1936. Franchet's type was from "Yunnan, Li-kiang monte Suée-chan, 4000 m. s.m. inter fragmina rupis calcareae (Delavay! in herb. Paris)." An isotype with Franchet's handwriting, in the Bonati Herbarium, will pass to the University of California at Los Angeles, with fragment at Academy of Natural Sciences of Philadelphia.

"*Pedicularis szetschuanica*" *sensu* Bonati, in Notes Bot. Gard. Edinb., 5: 91, 1911; 7: 145, 1912; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; in Repert. Sp. Nov., 20: 205, 1924, p.p.; *non* Maxim. Bonati and Limpricht both referred *Forrest* 2594 and Limpricht also referred *Schneider* 2048, 3472, and 3009 to *P. szetschuanica* Maxim., a species that does not extend to Yunnan. These Yunnan specimens, of which the three Schneider specimens are available for study, are clearly referable to *P. rupicola* Franch.

Alpine meadows, often in limestone gravel, at altitudes of 2745 to 4800 meters, in northwestern Yunnan and southeastern Sikang. Flowers purple. Flowering from May through September.

SIKANG: Yargong, *Soulié* 3748 (UCLA); Litang River divide, *Ward* 4019 (RBGE); Glacier Lake, *Ward* 4205 (RBGE); Mount Konka, Risonquemba, Konkaling, *Rock* 16375 p.p. (USNH); Kausho Shan, on trail to Leirong, southwest of Muli, *Rock* 24116 (NYBG, UC, UP, USNH); western slopes of Mt. Mitzuga, Muli Territory, *Rock* 23998 (NYBG, UC), 24527 (NYBG, UC, UP); Tsa-wa-rung, Ngaala, *C. W. Wang* 66044 (AA).

YUNNAN: no locality, *Forrest* s.n. (ANSP, UCLA), 28489 (ANSP), 28989 (ANSP), 30764 (ANSP), *Yü* 6468 (AA), 6576 (AA), 7409 (AA), 9663 (AA); Likiang, *Delavay* 2434 (ANSP, UCLA), *Schneider* 2048 (USNH); eastern slopes of Likiang Snow Range, *Forrest* 5994 (UCLA), 6193 (UCLA), *Rock* 4537 (USNH), 4697 (USNH), 4807 (USNH), 4808 (USNH), 5009 (USNH), 5465 (NYBG, USNH), 9613 (USNH); Likiang Snow Range, *Forrest* 6429 (UCLA), *Yü* 15346 (AA), *Ching* 30336 (AA), 30379 (AA); Chungtien Plateau, *Schneider* 3009 (USNH); mountains of Hsiao Chungtien, *Rock* 25268 p.p. (NYBG, UC, UP); Mt. Habashan, north of Ndaku, north of the Likiang Snow Range, *Rock* 9643 (ANSP, UC, USNH); mountains of Hungpo, west of Tung-chu-ling, overlooking Mekong, *Rock* 23411 (UC, UP, USNH); Mekong-Salween divide, *Forrest* 1443 (ANSP, UCLA); Mount Peimashan, between Atuntze and Fungtsera, *Rock* 10010 (USNH); Atuntse, *C. W. Wang* 70094 (AA).

67b. Pedicularis rupicola zambalensis Bonati

Pedicularis rupicola var. *zambalensis* Bonati, in Bull. Soc. Bot. France, 55: 313, 1908; Limpricht, in Repert. Sp. Nov., 20: 207, 1924. Bonati's type, "Zambala, pâturages humides des hautes montagnes: *R. P. Soulié* n° 3349, août 1903," has not been seen.

Alpine meadows in northwestern Yunnan and southern Sikang. Flowers purple. Flowering from May through September.

SIKANG: mountains between the Litang and Shou-Chu River, between Wa-Erh-Dje and Garu, *Rock* 16776 (ANSP, USNH); Minya Konka Snow Range, Muli Territory, *Rock* 17622 (ANSP, USNH), 23742 (NYBG, UC, UP); Muli Territory, Mountains of Kulu, *Rock* 18013 (ANSP, USNH), 18029 (ANSP, USNH); mountains of Yetsi, *Rock* 24423 (NYBG, UC, UP); Muli, *Handel-Mazzetti* 7288 (GH).

YUNNAN: Likiang, *Schneider* 3472 (USNH), 3782 (GH); Chungtien Plateau, *Forrest* 11160 (ANSP, RBGE, UCLA); northern flank of Haba Snow Range, *Feng* 2392 (AA); Kin-tsu Shan or Dsho-yu-nviu, district of Labako, west of Shi-ku, *Rock* 25135 (NYBG, UC, UP).

68. **Pedicularis lingelsheimiana** Limpricht

Pedicularis lingelsheimiana Limpricht, in Repert. Sp. Nov., 18: 244, 1922; 20: 205, 1924. Limpricht's type, "Ost-Tibet: Dege-Göntschin, Talhänge bei Kolo-ndo, 3850 m. no. 2148a als *P. cyathophylla* Franch. in Limpricht: Bot. Reis. l.c. p. 485 (1922)," has not been seen.

In Sikang. Flowers rose. Known from the original collection only. No specimen seen.

In 1922 Limpricht described *P. lingelsheimiana* based on *Limpricht* 2148a, which he had previously named as *P. cyathophylla* (in Repert. Sp. Nov. Beih., 12: 485, 1922). He indicated the species as belonging to "Bidentatae verticillatae" but mentioned that its relationship is with *P. szetschuanica* which has an edentate corolla and is of an entirely different group. In 1924, he listed this *P. lingelsheimiana* in the "Anodontae verticillatae" under the series Verticillatae close to *P. szetschuanica.* As he described the corolla as being toothed, this species is definitely not of the Verticillatae group and so not related to *P. szetschuanica.* It may be that the species is of the Superbae group as suggested by its identification as *P. cyathophylla.* He remarked also (in Repert. Sp. Nov., 20: 177, 1924): "Eine interessante Art ist die drüsige *P. Lingelsheimiana* aus der Gegend von Dege in Ost-Tibet. Dem Blütenbau nach eine echte *P. verticillata,* sieht sie habituell einer zweigigen *P. Lipskyana* sehr ähnlich und teilt auch mit ihr denselben Standort." The exact relationship and status of the species can not be ascertained without an actual examination of the type specimens.

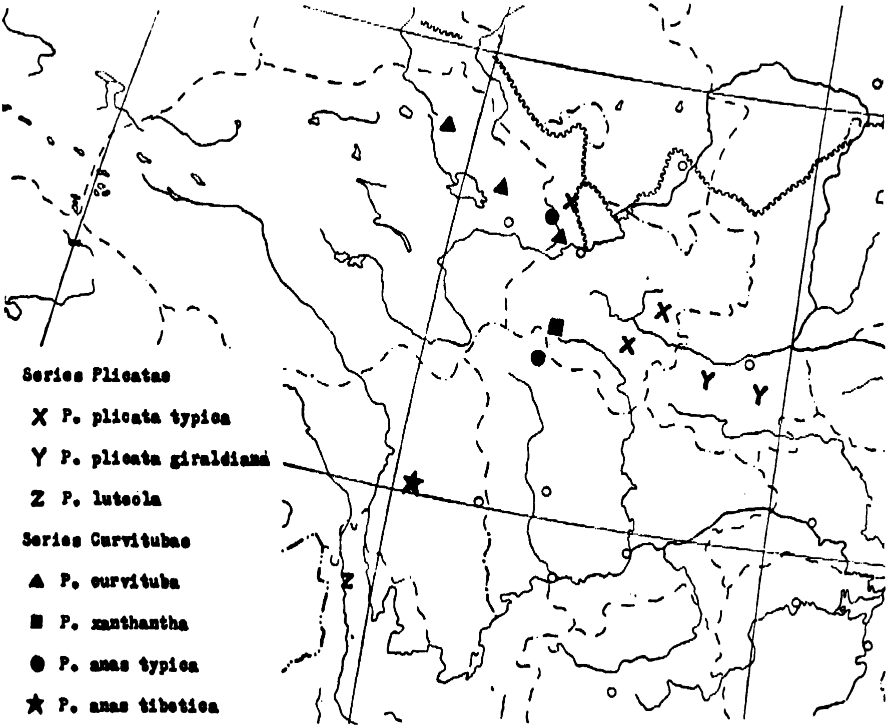
Series 15. Plicatae

Plicatae Prain, in Ann. Bot. Gard., Calcutta, 3: 95, 1890, p.p.

Low or tall plants, the stem single or branching at base, otherwise simple; leaves 4-verticillate, mostly cauline, ovate-oblong, pinnatisect, the segments pinnatifid to pinnatisect; inflorescences spicate, terminal, villose; calyx not reticulate, cleft anteriorly, 4-5-dentate, the teeth broad, deltoid to ovate, distinctly dentate; corolla yellow, rather large, 2-2.5 cm. long, the tube bending in the calyx, deflexed, the galea broad, 3-4.5 mm. wide, more or less enlarged distally, rounded in front and rounded or truncate at apex, the lower lip about as long as the galea; anther-pairs distinct, the cells attenuate and long-acuminate at base, staminal filaments glabrous.

Two species from southern Shensi, eastern Kansu to northwestern Yunnan (Map 10).

The series as originally defined by Prain consisted of two species, *P. plicata* and *P. rupicola*. The latter is here included in the Verticillatae. Limpricht (in Repert. Sp. Nov., 20: 206, 1924) added a number of species which are here also placed in the series Verticillatae. The series Plicatae is thus limited in its scope to include the species *P. plicata* with its variety *giraldiana,* and an additional new species. These two species can be distinguished from the series Verticillatae by their yellow corolla of relatively larger size, with more or less broad tube and galea, the latter usually enlarged distally and rounded, and by the anther-cells being attenuate and long-acuminate at base.



Map. 10.—Distribution of the series Plicatae and Curvitubae.

Key to the Species

A. Inflorescences sparsely villose; flower large, about 2.5 cm. long; calyx sparsely ciliate along the margin, less deeply cleft anteriorly; galea broader, 3-4.5 mm. wide, rounded at apex. .... 69. *P. plicata*

AA. Inflorescences densely villose; flowers smaller, about 2 cm. long; calyx densely long-ciliate along the margin, deeply cleft anteriorly; galea narrower, 3 mm. wide, truncate at apex. .... 70. *P. luteola*

69, Pedicularis plicata Maximowicz

This species is characterized, among other things, by the broad, more or less rounded galea, and the posteriorly long-attenuate, acuminate anther-cells. The species is apparently limited in its distribution to central and eastern Kansu, southern Shensi, and northern Szechuan, about the general region of the Tainling Range.

Key to the Varieties

A. Calyx about 6 mm. wide, the lobes 2-3 mm. long; galea broad, about 4-4.5 mm. wide, very much rounded at the apex. .... 69a. *P. p. typica*

AA. Calyx about 4 mm. wide, the lobes about 1-1.5 mm. long; galea narrower, about 3 mm. wide, less rounded at the apex. .... 69b. *P. p. giraldiana*

69a. Pedicularis plicata typica Plate 19, fig. 53.

Pedicularis plicata Maxim., in Bull. Acad. St. Pétersb., 32: 598, fig. 120, 1888; in Mél. Biol., 12: 888, fig. 120, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 213, 1890; Diels, in Bot. Jahrb., 36, Beib. 82: 97, 1905; Limpricht, in Repert. Sp. Nov., 20: 206, 1924, p.p.[21] Maximowicz's types were from: "*Kansu* orientali: cacumine montis Tschagola, *P. versicolori* admixta; *Szc-tschuan* boreali: trajectu Gumà-kikà, nec non ad fontes fl. Atu-Lunwa (Potanin, 1885)." A specimen of the syntype from Kansu, collected by Potanin on July 11, 1885, bearing the handwriting of Maximowicz, is in the Bonati Herbarium; it passes to the University of California at Los Angeles, with photograph at the Academy of Natural Sciences of Philadelphia.

Alpine regions among limestone rocks or on moist slopes, at altitudes of 2900 to 3500 meters, in Kansu and northern Szechuan. Flowers sulphur yellow. Flowering in July.

KANSU: eastern Kansu, Mt. Tschagola, *Potanin* s.n. (UCLA); central Kansu, Lien hoa shan, *Rock* 12784 (ANSP, GH, NYBG); Ta Hwa, near Pinfan, *Ching* 514 (USNH).

69b. Pedicularis plicata giraldiana (Diels) Limpricht

Pedicularis giraldiana Diels ex Bonati, in Bull. Soc. Bot. France. 57, Sess. Extraord.: lx, 1911; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922. Diels' types were from: "*Shense septentional* (*R. P. Giraldi*), n^{os} 1207-1211)." The author of this species is Diels, although Bonati gave it as "*Pedicularis Giraldiana* (Diels) Bonati" and Index Kewensis listed Bonati as the author. Bonati remarked: "Cette plante porte dans l'herbier du Muséum de Florence le nom do *P. Giraldiana* Diels; ce nom n'a jamais été publié, M. Diels m'en a donné lui-même l'assurance." Both *Giraldi* 1207 and 1211, ex herb. Florence Museum, are available for study.

Pedicularis plicata Maxim. var. *giraldiana* (Diels) Limpricht, in Repert. Sp. Nov., 20: 206, 1924 (as "giraldii"). This is a combination made by Limpricht, although he did not so indicate. He listed the name as "[*Pedicularis plicata* Maxim.] var. *Giraldii* (Diels) Bonati in Bull. Soc. Bot. France LVII (1910) 60 (als Art)." He cited *Giraldi* 5549, 1205, 1207, 1211, and *Limpricht* 2736. He also mentioned that this variety is scarcely distinguishable from the typical form of the species. Apparently the two forms are very close and Limpricht's reduction is very justifiable.

In southern Shensi. Flowers yellow. Flowering in August.

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[21] *Forrest* 14578 from Yunnan is not *P. plicata* as reported by Limpricht and also by the Staff of Edinburgh Botanic Garden (in Notes Bot. Gard. Edinb., 17: 80, 1929), the last-named determination being made by Bonati. This number represents a new species and is separately described below.

SHENSI: Tai-pei Shan, *Giraldi* 1207 (B), 1211 (ANSP).

This variety differs from the typical form of the species primarily in the narrower flowers; otherwise it agrees closely with the species.

70. Pedicularis luteola sp. nov. Plate 19, fig. 54.

"*Pedicularis plicata*" *sensu* Limpricht, in Repert. Sp. Nov., 220: 206, 1924, p.p.; Staff Bot. Gard. Edinb., in Notes Bot. Gard. Edinb., 17: 80, 1929; *non* Maxim.

Perennis, radice crassā; caulibus multis erectis simplicibus, plus minusve totis hirsutis, foliis 4-verticillatis, radicalibus paucis, longe petiolatis (petiolis 2.5-3 cm. longis, vix alatis, glabris), caulinis petiolatis (petiolis 1-1.5 cm. longis, late alatis, leviter hirsutis), membranaceis, glabris, ovato-oblongis, circiter 3-3.5 cm. longis, 1-1.5 cm. latis, pinnatisectis, rhachidibus distincte alatis, 1.5-2 mm. latis, segmentis utrinsecus 6-9, ovato-oblongis, ad 7 mm. longis et 4 mm. latis, pinnatisectis vel pinnatifidis, dentatis; inflorescentiis spicatis, 3-7 cm. longis, terminalibus, distincte denseque villosis, fasciculis inferioribus disjunctis, superioribus compactis; bracteis inferioribus foliaceis, pinnatisectis, superioribus ovato-oblongis, plus minusve integris, margine ciliatis; floribus dense aggregatis pedicellis circiter 3 mm. longis; calyce ovato-oblongo, circiter 1 cm. longo, sensim accrescente, membranaceo, ciliato, circiter 8-costato, antice profunde fisso, irregulariter 5-dentato, dentibus parvis, plus minusve ovato-triangularibus, serratis, profunde inaequalibus; corollā luteā, circiter 1.8 cm. longā, omnino glabrā, in calyce incurvatā, valde deflexā: tubo supra calycem recto, circiter 1 cm. longo, superne profunde dilatato; galeā circiter 6 mm. longā, fronte rotundatā, apice inferiore acutā, margine inferiore integrā; labio inferiore circiter 8 mm. longo, lobis rotundatis, integris, lobo medio parvo, optime porrecto; staminibus ad basim tubi inserti, filamentis totis glabris, loculis basi attenuatis acuminatis; capsulis ignotis.

Type, moist stony pastures, in northwestern Yunnan, Mekong-Salween divide, at Lat. 28° 12′ N., altitude of 3660 meters, collected in flower, Aug. 1917, by G. Forrest, No. 14578; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the Bonati Herbarium, to be deposited in the herbarium of the University of California at Los Angeles. Flowers pale yellow. Only collection seen.

The alliance of this species is undoubtedly with *P. plicata*, but clearly they are specifically distinct. It resembles *P. plicata* in the anteriorly cleft calyx with unequal dentate teeth, the yellow corolla, the glabrous filaments, and the acuminate-based anther-cells. It differs from the latter in the leaves being wider and more cut, the inflorescences more villose, the flowers much smaller, the calyx relatively larger, more deeply cleft anteriorly and densely ciliate along the margins, the corolla more deflexed, the galea pronouncedly acute at the apex, and the anther-cells with less attenuate bases.

Series 16. Curvitubae ser. nov.

Low or tall plants; stems single or branching at base, not branching above, slightly hirsute to glabrate; leaves 4-verticillate, oblong-lanceolate to linear, pinnatisect, the segments pinnatifid to serrate; flowers in more or less interrupted racemes; bracts ovate, entire to serrate above; calyx ovoid, slightly cleft anteriorly, unequally 5-dentate, the teeth deltoid to ovate, dentate to serrate; corolla purple or yellow, strongly bending in the calyx and again upcurved above the calyx at the junction of the tube and the galea; galea slightly bending distally, the apex produced into a more or less horizontal, short beak; lower lip 3-lobed, the lobes rounded to slightly truncate, the mid-anterior slightly smaller and more distad; filaments glabrous or hairy.

Three species in Kansu, Chinghai, and Sikang (Map 10).

This series is being separated from the Myriophyllae so as to include those species that have the corolla strongly bending in the calyx and also upcurved above the calyx at the junction of the galea and the tube. They represent a group that is phylogenetically related to the series Verticillatae, a beakless group with similarly curved corolla.

Key to the Species

A. Calyx-teeth oblong-ovate, pinnatifid to serrate; corolla yellow, the galea slender and relatively longer, the lower lip larger and broader, the lobes rounded and finely reticulate without a conspicuous middle vein; staminal filaments all hairy. 71. *P. curvituba*

AA. Calyx-teeth deltoid to subovate, dentate; corolla purple or yellow, the galea relatively shorter, the lower lip smaller and narrower, the lobes rounded and slightly truncate, sparsely reticulate with a conspicuous middle vein; staminal filaments all glabrous.

  B. Corolla yellow, more prominently bending and upcurved at the junction of the galea and the tube; beak more prominent, about 2 mm. long. 72. *P. xanthantha*

  BB. Corolla purple, less prominently bending and upcurved at the junction of the galea and the tube; beak less prominent, about 1 mm. long. .. 73. *P. anas*

71. **Pedicularis curvituba** Maximowicz

Pedicularis curvituba Maxim., in Bull. Acad. St. Pétersb., 24: 60, 1878; 32: 578, fig. 85, 1888; in Mél. Biol., 10: 92, 1898; 12: 859, fig. 85, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 207, 1890; Limpricht, in Repert. Sp. Nov., 20: 242, 1924. The type, "prov. Kansu, vallibus rivulorum alpinorum vulgaris (Przewalski)," has not been seen.

In northern Kansu and Chinghai. No specimen seen.

72. **Pedicularis xanthantha** sp. nov. Plate 19, fig. 55.

Pedicularis anas Maxim. var., Mus. Bot. Berol. ex Rehder & Kobuski, in Journ. Arnold Arb., 14: 32, 1933.

Perennis, caulibus simplicibus vel ad basim longe ramosis, 2-2.5 dm. altis, paulo hirsutis vel glabratis, 2-3-nodis, ramis erectis; foliis radicalibus paucis deciduis, longe petiolatis (petiolis ad 2 cm. longis, leviter alatis), caulinis 4-verticillatis, petiolatis (petiolis 0.5-1 cm. longis, leviter alatis, 1 mm. latis) oblongo-lanceolatis, circiter 2.2 cm. longis et 8 mm. latis, glabris

vel leviter pilosis, pinnatisectis, segmentis utrinsecus 10-12, plus minusve distantibus, ovato-oblongis, profunde pinnatifidis, rhachidibus leviter alatis, circiter 1 mm. latis; inflorescentiis terminalibus spicatis, compactis interruptisve, ad 6 cm. longis; bracteis inferioribus foliaceis, pinnatisectis, segmentis pinnatifidis, superioribus ovatis, circiter 5 mm. longis et 3 mm. latis, inferne integris, superne serratis vel subintegris; pedicellis circiter 2 mm. longis; calyce ovoideo membranaceo, leviter ciliato vel subglabro, circiter 8-costato, anteriore leviter fisso, 5-dentato, margine ciliato, dentibus inaequalibus deltoideis, serrulatis; corollā luteā, circiter 18 mm. longā, glabrā, in calyce infractā, supra calycem curvatā inflexā: tubo 8 mm. longo, superne ampliato; galeā 10 mm. longā, rectā, in rostrum productā, rostro plano, 2 mm. longo; labio inferiore circiter 9 mm. longo, 3-lobato, lobis rotundatis vel subtruncatis, costā distinctā, lobo medio parvo porrecto; staminibus ad basim tubi insertis, filamentis omnino glabris, antheris contiguis, loculis basi acutis; stylo exserto; capsulis ignotis.

Type, in alpine meadows, at altitudes of 3350 to 3650 meters, in the northern slopes of the Minshan Range, west of Main Shamen, Upper Tebbu country, in the southwestern part of Kansu Province, collected in flower, July-Aug. 1925, by J. F. Rock, No. 13035; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotypes in the Gray Herbarium and the herbarium of the New York Botanical Garden. Flowers yellow. Only collection seen.

This species is very close to *P. anas* but is clearly specifically distinct. It is a larger and taller plant with broader leaves. The corolla is yellow, more conspicuously curved in the middle and so the galea more erect. The beak is longer and more prominent.

73. **Pedicularis anas** Maximowicz

As here recognized, following Bonati, includes two varieties.

73a. **Pedicularis anas** typica Plate 19, fig. 56.

Pedicularis anas Maxim., in Bull. Acad. St. Pétersb., 32: 578, fig. 87, 1888; in Mél. Biol., 12: 860, fig. 87, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 205, 1890; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; in Repert. Sp. Nov., 20: 243, 1924; Walker, in Contr. U. S. Nat. Herb., 28: 659, 1941. The type, "Prov. Sze-tschuan: circa custodium Dshin-dshe-tan (Potanin, 1885)," has not been seen. The original description and illustration are very distinctive.

Alpine meadows, at altitudes of about 3000 to 3350 meters, in northern Szechuan and southern Kansu. Flowers purple. Flowering in July.

KANSU: Dar Pan, near Sining, *Ching* 645 (ANSP, USNH).

73b. **Pedicularis anas tibetica** Bonati

Pedicularis anas var. *tibetica* Bonati, in Bull. Herb. Boiss. II, 7: 544, 1907; Limpricht, in Repert. Sp. Nov., 20: 243, 1924. The type was from Sikang: " (Typus in herb. Barbey-Boisser). Soulié n° 274; Tongolo." It has not been seen. This variety differs from the typical form of the species, according to Bonati, by the lower leaves being long-petiolate, by the beak being relatively longer, and especially by the lower lip being much smaller. No specimen has been seen.

SECTION IV. CYATHOPHORA

Erect, usually tall plants; stems simple or branching above, sometimes branched near the base; leaves 4-verticillate, pinnatisect, the segments pinnatifid to pinnatisect, serrate, with the bases of the petioles or of the bracts dilated and connate; calyx campanulate to cylindric, more or less cleft anteriorly, 2-5-dentate, the teeth entire to serrate; corolla-tube short, slightly exceeding the calyx, enlarged distally or in some species becoming cylindric and very long; galea with or without a beak, the lower margins usually provided with a protuberance in the middle, and in beakless species usually with a tooth on each side of the apex.

This section is strongly characterised and readily distinguished by the dilated connate bases of the petioles or the bracts. The species comprising the section represent a very natural group. The corolla, however, exhibits considerable variations from the toothed to the beaked, and to the very long-tubular conditions. The development of the various forms of corollas in this group is evidently independent of other groups.

The species of this section were formerly all grouped in one series, the "Superbae." In view of the fact that considerable differentiation of the corolla is present, this group is made into a section, and the species with different types of corolla are accounted as series.

This section is limited in its range to southern and northern Yunnan, adjacent southeastern Sikang, and southern Szechuan. The greatest concentration of both species and varieties, as well as individual plants, is in northwestern alpine Yunnan.

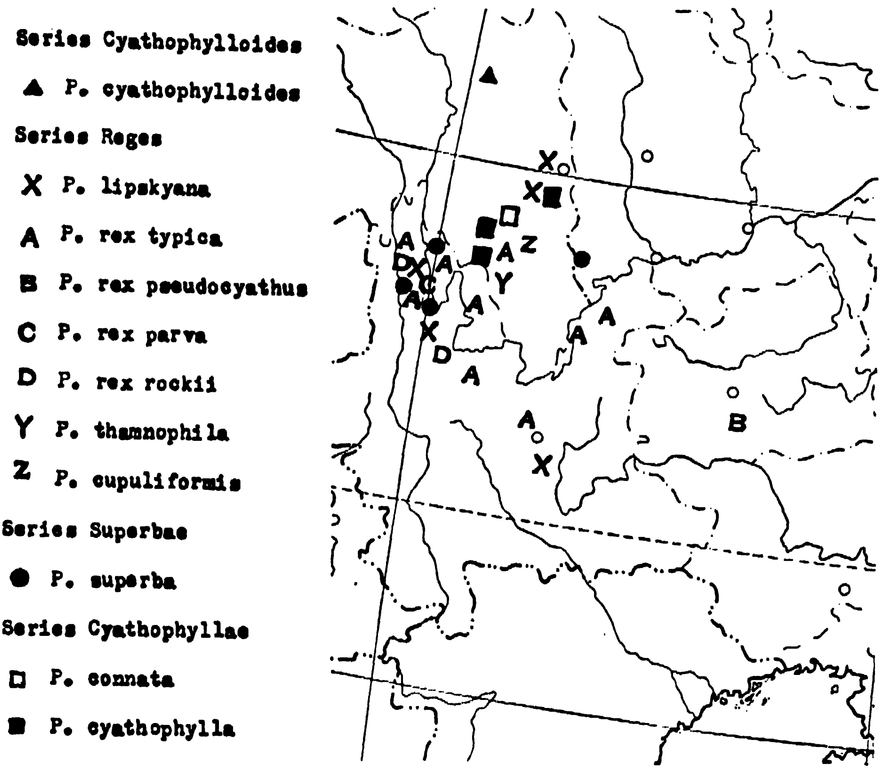
Series 17. Cyathophylloides ser. nov.

Erect, the stems simple or usually branching at the base; leaves 4-verticillate, pinnatisect, the segments pinnatifid, serrate; bases of petioles and bracts greatly dilated and connate; calyx chartaceous, campanulate, ciliate along the nerves, reticulate, slightly cleft anteriorly, 5-dentate, the teeth ovate, serrate; corolla purple; tube about twice as long as the calyx, slightly enlarged distally; galea rounded and enlarged distally, more or less finely puberulous, the apex slightly protruded, pointing outward, truncate, edentate to very obscurely 1-dentate; lower lip very broad, longer than the galea, the anterior lobe as large as the lateral ones; staminal filaments all hairy; styles included.

One species in Sikang (Map 11).

74. Pedicularis cyathophylloides Limpricht Plate 19, fig. 57.

Pedicularis cyathophylloides Limpricht, in Repert. Sp. Nov., 18: 243, 1922; 20: 225, 1924. "Ost-Tibet: Dege-Göntschin, Talhänge bei Kolo ndo. 3850 m. (no. 2148 sub *P. cyathophylla* Franch. in Limpricht: Bot. Reis. l.c. p. 214 u. 485)." The type locality is now in the northern part of Sikang Province. Isotypes, in the Breslau Herbarium (whence apparently borrowed by G. Bonati) and in the herbarium of the Academy of Natural Sciences of Philadelphia, are available for study.



Map 11.—Distribution of the series Cyathophylloides, Reges, Superbae, and Cyathophyllae.

"*Pedicularis cyathophylla*" *sensu* Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922, p.p.; *non* Franch. Limpricht cited No. 2148 as representing *P. cyathophylla* Franch.; the same number was subsequently used as the type of *P. cyathophylloides* Limpricht. Limpricht described the filaments as all glabrous, but close examination of the type specimens shows that all filaments are villose.

At an altitude of about 3850 meters, in northern Sikang. Known from the original collection only. Flowers rose. Flowering in August.

SIKANG: Dege-Göntschin, Kolo ndo, *Limpricht* 2148 (Breslau, ANSP).

Series 18. Reges ser. nov.

Superbae Maxim., in Bull. Acad. St. Pétersb., 32: 589, 1888; in Mél. Biol., 12: 873, 1888, p.p.

Erect, tall or low, the stem simple or branched above, sometimes also branched near the base; leaves 4-verticillate, sometimes opposite or ternate, pinnatisect, the segments pinnatisect to pinnatifid, serrate; bases of petioles and bracts often greatly dilated and connate; calyx small, ovoid, very membranaceous, glabrous, not reticulate, cleft anteriorly, 2-dentate, the teeth rounded, short, usually entire; corolla red, purple to yellow; tube about 2-2½ times as long as the calyx, slightly enlarged distally; galea rounded and much enlarged distally, more or less pubescent, the apex truncate, pointing downward, usually with one tooth on each side of the lower margin; lower lip shorter than the galea, not broad, the mid-anterior lobe very small; staminal filaments all hairy or nearly so.

About 4 species in Kweichow, northern Yunnan, and eastern Sikang (Map 11).

Key to the Species

A. Leaves mostly 4-verticillate, sometimes ternate; all petiole-bases of the leaves, except sometimes the lower ones, and those of bracts enlarged and connate; leaf-segments pinnatifid, the lobes usually shallowly serrate; stems more or less glabrous.

  B. Corolla purplish or reddish; staminal filaments hairy distally. 75. *P. lipskyana*

  BB. Corolla yellow; staminal filaments hairy throughout. .... 76. *P. rex*

AA. Leaves mostly ternate, sometimes opposite or rarely 4-verticillate; petiole-bases of the leaves usually not enlarged and connate, but those of the bracts always enlarged and connate at base; leaf-segments pinnatisect, the lobes sharply serrate; stems more or less pilose.

  B. Plant tall, 2.5 dm. or more tall, the stem long-branching throughout the whole length; leaves broad, 5-8 cm. wide; posterior filaments glabrous or nearly so. .... 77. *P. thamnophila*

  BB. Plant low, to 1.5 dm. tall, the stem long-branching near the base only; leaves narrow, to 2 cm. wide; posterior filaments more or less densely hairy distally. 78. *P. cupuliformis*

75. Pedicularis lipskyana Bonati . Plate 19, fig. 58.

Pedicularis rex Clarke var. *purpurea* Bonati, in Bull. Soc. Bot. France, 55: 311, 1908. "*Habit.*—? (*R. P. Soulié*) n° 2063. Existe également dans la collection rapportée du Hupeh par M. Wilson (herb. Kew!)." This Wilson number is probably the same as the one referred to below.

Pedicularis lipskyana Bonati, in Bull. Bot. Soc. France, 57, Sess. Extraord.: lviii, 1911; Limpricht, in Repert. Sp. Nov., 20: 224, 1924. Bonati raised his *P. rex* Clarke var. *purpurea* of 1908 to specific status and cited, in addition to his 1908 citations, the following collections: *Potanin* s.n. from Ta-tsien-lou and *Wilson* 4277 from western China. The Potanin specimen in the Bonati Herbarium was originally determined by V. J. Lipski as *P. superba* Franch. It was named by Bonati as *P. lipskyana*. Wilson's specimen (ex Kew) is also in the Bonati Herbarium.

Pedicularis lamarum Limpricht, in Repert. Sp. Nov., 18: 243, 1922. "Ost-Tibet: Dawo (Ressenyi), um das Lamakloster Bélo setscho westlich Tschi see tsung, 4050 m. (no. 1949 in Limpricht: Bot. Reis. l.c. p. 485. als *P. cyathophylla* Franch. bezeichnet)." This was reduced to the synonymy of *P. lipskyana* Bonati by Limpricht himself in 1924 (in Repert. Sp. Nov., 20: 224, 1924).

"*Pedicularis cyathophylla*" *sensu* Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922, p.p.; *non* Franch. Limpricht cited *Limpricht* 1949 as representing *P. cyathophylla* which he subsequently described as *P. lamarum* Limpricht.

Open grassy or rocky slopes or ravines, at altitudes of 1930 to 3800 meters, in northwestern Yunnan and eastern Sikang. Flowers pink to red. Flowering in July and August.

WESTERN CHINA: no locality, *Wilson* 4227 (UCLA).

SIKANG: Ta-tsien-lu, *Potanin* s.n. (UCLA); Kanting, Ta-a-ah, *Chiao* 1848 (AA); Konkaling, Mula, *Yü* 13265 (AA), Baurong to Tachienlu, via Hadjaha, *Stevens* 312 (CM).

YUNNAN: Likiang District, *C. W. Wang* 71537 (AA); Likiang Snow Range, *Yü* 15311 (AA); Cheng-kiang, Chi-ling Shan, *H. Wang* 41635 (AA); no locality, *Yü* 9872 (AA).

This species is very close to *P. rex*. Bonati described the filaments as 2 of them hairy and Limpricht as all glabrous. An examination of a number of specimens shows that the staminal filaments are all hairy, sometimes only slightly so distally. The species resembles closely *P. rex* in most of its characters and it may eventually prove desirable to return it to varietal status under that species.

76. Pedicularis rex C. B. Clarke

Pedicularis rex is a variable species. The corolla varies considerably in size, and may be entirely glabrous or very hairy on both the galea and the tube. In many cases these variations may be present on a single plant. The calyx is very membranaceous, cleft anteriorly and 2-dentate posteriorly. The two calyx-teeth may be either entire or slightly 2-3-dentate. The filaments are all hairy. Bonati recognized a number of species out of this group. I tend to agree with Handel-Mazzetti that the extreme forms be recognized as varieties instead of giving them the rank of distinct species.

Key to the Varieties

A. Plants with long internodes, usually to 3-10 cm. or more in length; teeth on the galea always present, subulate.
    B. Plants tall, usually 2.5 dm. or more tall; calyx-teeth frequently entire or shallowly 2-3-dentate.
        C. Stems usually not branched at base; radical leaves long-petiolate, caducous; flowers larger, 3.5-4 cm. long. .... 76a. *typica*
        CC. Stems branching at base; radical leaves short-petiolate, persistent; flowers smaller, about 2-2.5 cm. long. .... 76b. *pseudocyathus*
    BB. Plants low, less than 2 dm. tall; calyx-teeth distinctly 2-3-dentate. 76c. *parva*
AA. Plant with short internodes of about 2-3 cm. long; teeth on the galea sometimes absent. .... 76d. *rockii*

76a. Pedicularis rex typica Plate 19, fig. 59.

Pedicularis rex C. B. Clarke ex Maxim., in Bull. Acad. St. Pétersb., 32: 589, fig. 103, 1888; in Mél. Biol., 12: 875, fig. 103, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 214, 1890; Diels, in Bot. Jahrb., 29: 572, 1900; Bonati, in Notes Bot. Gard. Edinb., 5: 89, 1911; 7: 82, 134, 242, 1912; 8: 42, 1913; 15: 151, 1926; Limpricht, in Repert. Sp. Nov., 20: 224, 1924; 23: 334, 1927; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 218, 1934; Hand.-Maz., Symb. Sin., 7: 853, 1936. Clarke's types were from various localities: "*Himalaya:* Khasia, ad Shillong, 6000 p. s.m. (C. B. Clarke! 1885); *Burma* (Brandis! in hb. Calcutt.); *China:* Yunnan, ad Tsang-shan supra Tali (Delavay! in hb. Paris), prov. Kwei-tschou (Perry! ibid.)." A specimen of the Delavay collection is in the Bonati Herbarium. The corolla is fairly villose on the galea. A duplicate of Brandis s.n. in the Dehra Dun Herbarium has also been seen.

Pedicularis lopingensis Hand.-Maz., in Anz. Akad. Wiss. Wien, 62: 238, 1925; Limpricht, in Repert. Sp. Nov., 23: 335, 1927.

Pedicularis rex C. B. Clarke var. *lopingensis* Hand.-Maz., Symb. Sin., 7: 854, 1936. Handel-Mazzetti's type of *P. lopingensis* was from "Prov. Yünnan orient. In agris reg. calide temperatae ad montem Belingschan prope oppidum Loping copiose, s. calceo, 1900-2100 *m.* legi 10.-11. VI. 1917 (Nr. 10.208)." The type has not been seen, but the descriptions show that it is within the variable limits of this species.

Pedicularis mahoangensis Bonati, in Notes Bot. Gard. Edinb., 15: 152, 1926; Limpricht, in Repert. Sp. Nov., 23: 335, 1927. Bonati's type was from "'Yunnan: Yangtse watershed, Prefectural District of Likiang, eastern slopes of Likiang Snow Range; above Mahoang Patze. 12-14,000 ft. Stem shiny yellow; flowers yellow. June 24, 1922.' J. F. Rock. No. 4680." Isotypes are in the herbaria of the Academy of Natural Sciences of Philadelphia and the University of California. These specimens do not reveal any difference from other typical specimens of *P. rex.* Bonati emphasized the larger size of the corolla, about 4 cm. long, but Clarke gave the same length for *P. rex.* Other characters, such as dentate calyx-teeth, villose corolla, etc., all fall within the variable limits of the species now considered. Handel-Mazzetti (Symb. Sin., 7: 854, 1936), expressed the opinion that *P. mahoangensis* is scarcely a variety of *P. rex.*

Open pastures or on slopes or in coniferous forests, sometimes in ravines, at altitudes of 2500 to 4300 meters, in Yunnan, Sikang, Upper Burma, and the eastern Himalayas. Flowers yellow. Flowering from June through August.

SIKANG: Muli, *Ward* 4759 (RBGE); Muli, mountains between the Litang and Yalung Rivers, between Muli Gomba and Baurong to Wa-Erh-Dje, *Rock* 16725 (ANSP, USNH); Muli, Kulu, *Rock* 18212 (ANSP, USNH), *Yü* 14308 (AA).

YUNNAN: Tsang chan, Tali, *Delavay* 333 (ANSP, UCLA); Tchao Tcheon, *Delavay* s.n. (UCLA); Youngpe, *Ten* 144 (RBGE); Yunnan sen, *Ducloux* 695 (ANSP, UCLA), 902 (ANSP, UCLA, USNH), *Maire* 696 (UC); Tong Tchouan, *Maire* s.n. (ANSP, UCLA, USNH), 6142 B (ANSP, UCLA); eastern flank of the Tali Range, *Forrest* 4502 (ANSP, UCLA), 28188 (ANSP); Mengtse, *Henry* 9957 (USNH), 9597 A (NYBG); Yunnan fu, Lan tsching, *Schoch* 166 (USNH); Chio-kia District, *Tsai* 52032 (AA); Pin-chuan District, *Tsai* 52950 (AA); western slopes of Likiang Snow Range, Ashi Road, *Rock* 4621 (USNH), *Ching* 20741 (AA); eastern slopes of Likiang Snow Range, *Forrest* 2477 (UCLA), 6157 (UCLA), *Rock* 4680 (ANSP, USNH), eastern slopes of Likiang Snow Range, Na Cho above the Mahoang Patze, *Rock* 5948 (USNH); northeastern Likiang, Ta-chi on the bank of the Yangtse, *Ching* 21257 (AA); Young-ning, Mt. Wuaha, *Rock* 24232 A (NYBG, UC, UP), 24605 (NYBG, UC, UP); Likiang, *C. W. Wang* 70743 (AA); Likiang Snow Range, *Ching* 30291 (AA); Wei-si District, *C. W. Wang* 63893 (AA), 64383 (AA), 68239 (AA); Atuntze, Bei-ma-sha, *C. W. Wang* 69697 (AA); Chungtien, Haba, *Yü* 13498 (AA); Chungtien Plateau, *Feng* 1574 (AA); Chenkang, Snow Range, Hiao-shui-shan, *Yü* 17221 (AA); northern flank of Haba Snow Range, *Feng* 1237 (AA); Salween Valley, Bahanlo, *Yü* 22901 (AA); no localities, *Monbeig* s.n. (UCLA), *Tsai* 57109 A (AA), 57348 (AA), *Yü* 6527 (AA), 12633 (AA).

Among the specimens cited, *Rock* 24605 and 24232A bear both flowers and fruits. Others, like *Wang* 69697, *Tsai* 52032, *Yü* 13498, 22901, are wholly fruiting specimens. The fruit is broadly compressed-ovoid, acute, slightly mucronate, about 2-2.5 cm. long and 1-1.2 cm. wide.

76b. Pedicularis rex pseudocyathus Vaniot

Pedicularis rex C. B. Clarke var. *pseudocyathus* Vaniot ex Bonati, in Bull. Acad. Geogr. Bot., 13: 240, 1904; Limpricht, in Repert. Sp. Nov., 20: 224, 1924. The type is from "Kouy-Tchéou, montagne de Lou-tsang-Koan CC. (fleurs jaunes) Leg. E. Bodinier 16 mai 1897, no. 1594." A duplicate in the Edinburgh Herbarium has been seen. The type locality is in Kweichow Province.

Kweichow. Known from the original collection only. Flowers yellow. Flowering in May.

KWEICHOW: Lou-tsang-Koan, *Bodinier* 1594 (RBGE).

76c. Pedicularis rex parva Bonati

Pedicularis rex C. B. Clarke var. *parva* Bonati, in Notes Bot. Gard. Edinb., 15: 151, 1926; Limpricht, in Repert. Sp. Nov., 23: 334, 1927. Bonati's type was from "'Yunnan: south of Nguluko. 9000 ft. Flowers yellow. July 23, 1923.' J. F. Rock No. 9470." Isotypes are in the Bonati Herbarium, to pass to Academy of Natural Sciences of Philadelphia, and in the herbarium of the University of California.

In northwestern Yunnan. Known from the original collection only. Flowers yellow. Flowering in July.

YUNNAN: eastern slopes of Likiang Snow Range, south of Nguluko, *Rock* 9470 (ANSP, UC).

76d. Pedicularis rex rockii (Bonati) comb. nov.

Pedicularis rockii Bonati, in Notes Bot. Gard. Edinb., 15: 152, 1926; Limpricht, in Repert. Sp. Nov., 23: 335, 1927. Bonati's types were from Yunnan: "'Yunnan: mountains south of Likiang, near Hochin and Chiuho. Flowers yellow. May 25-28, 1922.' J. F. Rock. No. 4050. 'Yunnan: Yangtse drainage basin, north of Shiku and east of Weihsi, near Beifeng Chiang, bamboo forests. Oct. 1923.' J. F. Rock. No. 11533." Duplicates of both numbers, as listed below, were examined. Bonati stated that the galea has entire margins, but on the several sheets of *Rock* 4050 both toothed and toothless conditions appear on flowers of the same specimen. Bonati also gave the length of the corolla as 12-15 mm. long, but actually the corollas measure 15-22 mm. long.

Open slopes, at an altitude of about 3000 meters, in northwestern Yunnan. Flowers yellow. Flowering from May to July.

YUNNAN: mountains south of Likiang, near Hochin and Chiuho, *Rock* 4050 (ANSP, UC, USNH); eastern slopes of the Likiang Snow Range, *Rock* 4887 (USNH); Yangtse drainage basin north of the Shiku and east of Weihsi near Beifeng Chiang, *Rock* 11533 (ANSP); Tali District, *Tsai* 53810 (AA).

In establishing the species *P. rockii*, Bonati distinguished it from *P. rex* because the corolla is of the "Anodonta" type; otherwise it agrees with that of the latter species and its many varieties. However, both toothed and toothless conditions appear on specimens of the original collections. The teeth, whenever present, are more or less subulate and very distinct. The plants have, in general, slightly smaller corollas as well as more compact leaves (the internodes are 2-3 cm. long) than the typical form of the species. The various characters, although not very constant and with intermediates, nevertheless when combined seem to justify the differentiation of a variety from the variable species *P. rex*.

The existence of both distinctly toothed galea as well as toothless ones on the same specimen shows that the two teeth on the galea are the mucronate tips of the midribs of the original two corolla-lobes that form the galea. They tend to diminish in size, and the ultimate condition is their total disappearance. This clearly shows that these teeth are not a secondary growth but are actually a primitive character of the galea.

77. Pedicularis thamnophila (Handel-Mazzetti) comb. nov. Plate 20, fig. 60.

Pedicularis rex var. *thamnophila* Hand.-Maz., Symb. Sin., 7: 854, 1936. "NW-Y[unnan]: Bei Yungning jenseits des nach Fongkou führenden Passes, 16. VII. 1915 (7043, Typus). S[zechuan]: Unter der Wiese Dapindze zwischen Muli und Yungning, 24. VII. 1915 (7186)." A duplicate of the paratype, *Handel-Mazzetti* 7186, has been seen in the United States National Herbarium.

Plant erect, tall, 2-6 dm. tall, more or less furfuraceous and glandulose-pilose especially above; stems single, long-branching throughout, the branches opposite or ternate; leaves all cauline, opposite or ternate, rarely 4-verticillate, petiolate, the petioles hairy, 1.5-2.5 cm. long, winged or slightly enlarged but not connate, the blade broadly ovate to oblong, pinnatisect, the rachis slightly winged, the segments 9-12 on each side, linear-oblong, distant, to 1 cm. broad, membranaceous, glabrous or scarcely hairy, pinnatisect to deeply pinnatifid, the lobules distinctly and sharply serrate; inflorescences terminating the main branches, 2-4 nodes long, or terminating short lateral branches of only one node; bracts usually ternate, foliaceous, the petioles enlarged and connate into a cup to 1.5 cm. long, glabrous to sparsely villose externally, the blades oblong, pinnatisect with pinnatifid and serrate segments; flowers usually three to a node, sessile or nearly so; calyx ovoid, about 7-8 mm. long, membranaceous, 4-costate, with a few additional fine nerves, not reticulate, villose along the veins externally, cleft to the middle anteriorly, 2-lobed posteriorly, the lobes rounded, entire; corolla yellow, about 2-2.5 cm. long, hairy on the tube and galea, the tube erect, about twice as long as the calyx, slightly enlarged distally; galea erect, about as long as the tube, bending distally, the apex truncate and 1-dentate on each side of the lower margins; lower lip about 7-8 mm. long, 3-lobed, the lobes rounded, the margins finely ciliate, the middle lobe smaller, slightly distad; staminal filaments inserted at the lower third of the tube, the anterior more or less densely hairy distally, the posterior glabrous throughout or scarcely hairy distally, the anthers about 3.5 mm. long; stigmas scarcely exserted; capsules unknown.

Spruce forests and alpine meadows, at altitudes of 3200 to 3500 meters, in eastern Sikang and northwestern Yunnan. Flowers yellow. Flowering in June and July.

SIKANG: Muli territory, Dapindse, Yungning, *Handel-Mazzetti* 7186 (USNH); Mount Mitsuga, west of Muli Gomba, *Rock* 16230 (ANSP, USNH).

This species is related to *P. rex*, but differs in the more or less furfuraceous and glandulose-pilose habit, in the relatively broader and much more finely dissected leaves, and in the petioles of the leaves not being sheathed and united. The leaf-blades are often ternate. The inflorescences are found either at the tip of the main branches with 2-4 nodes of flowers subtended by connate cupulate bracts or at the tip of short lateral branches with only one node at the tip. The flowers resemble those of *P. rex* except that they are generally smaller and with the anterior filaments hairy distally while the posterior ones are nearly glabrous throughout.

78. Pedicularis cupuliformis sp. nov. Plate 20, fig. 61.

Planta nana, vix 1.5 dm. longa, plus minusve densata; caulibus ad basim multiramosis, rectis, plus minusve pilosis; foliis radicalibus caulinisque, radicalibus inferioribusque majoribus, caulinis oppositis vel ternatis, rarius

4-verticillatis, longe petiolatis (petiolis ad 4 cm. longis, leviter pilosis, non connatis), membranaceis, pinnatisectis, glabris, oblongis vel linearo-oblongis, ad 7 cm. longis et 2 cm. latis, rhachidibus leviter alatis, sparse pilosis vel glabris, segmentis utrinsecus 9-12, oblongis, remotis, circiter 4 mm. latis, pinnatisectis vel profunde pinnatifidis, lobis distincte serratis; inflorescentiis terminalibus, 2-4-nodis, interdum brevo-ramulis 1-nodis terminalibus; bracteis foliaceis, inferne petiolatis dilatatis connatis cupuliformibus, ad 1 cm. longis, extus ad costam pilosis, superne ovatis vel oblongis, pinnatisectis; floribus sessilibus vel subsessilibus; calyce ovoideo, 6-7 mm. longo, membranaceo, 4-costato, haud reticulato, extus ad costam villoso, antice ad medium fisso, postice 2-lobato, lobis rotundatis integris; corollā luteā 1.8-2.5 cm. longā, plus minusve villosā: tubo recto, calycem duplo superante, superne leviter ampliatā; galeā recto, superne leviter curvatā, apice truncatā, margine utrinsecus 1-dentatā; labio inferiore galeā breviore, lobis rotundatis, margine ciliatis, lobo medio parvo prominulo; staminibus ⅓ inferiore tubi insertis, filamentis ad apicem hirsutis, antheris 2.5 mm. longis; stylo vix exserto; capsulis ignotis.

Type, in meadows in fir forests, at an altitude of about 4000 meters, in mountains between the Litang and Yalung Rivers, between Muli Gomba and Baurong and Wa-Erh-Dje, Muli Territory, Sikang Province, collected in flower, July 1928, by J. F. Rock, No. 16692; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium. Flowers yellow. Only collection seen.

In the finely dissected leaves, the absence of connate petiole-bases on ordinary leaves and the presence of the same on bracts subtending the flowers, it is very near *P. thamnophila*. It differs from the latter in the small size, dense and compact habit, and the much narrower leaves. The flowers are smaller, with smaller anthers, and with staminal filaments that are all hairy distally.

Series 19. Superbae

Superbae Maxim., in Bull. Acad. St. Pétersb., 32: 589, 1888; in Mél. Biol., 12: 873, 1888, p.p.

Tall, erect, the stem simple, robust; leaves 4-verticillate, pinnatisect, the segments pinnatifid, denticulate, the base of the petioles and bracts greatly dilated and connate; calyx campanulate, slightly hirsute, reticulate, slightly cleft anteriorly, 5-dentate, the teeth more or less unequal, ovate, serrate to doubly serrate; corolla purple to purplish red, glabrous; tube about twice as long as the calyx, slightly enlarged distally; galea ending in a prominent beak; lower lip broad, the margins very finely ciliate, the middle lobe truncate and slightly smaller, the lateral lobes rounded; all staminal filaments hairy distally.

One species in southern Sikang and northwestern Yunnan (Map 11).

79. Pedicularis superba Franchet Plate 20, fig. 62.

Pedicularis superba Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 588, fig. 102, 1888; in Mél. Biol., 12: 874, fig. 102, 1888; Forbes & Hemsl., in Journ. Linn. Soc.

Bot., 26: 217, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 90, 1911; 7: 164, 1912; 8: 42, 1912; 15: 154, 1926; Limpricht, in Repert. Sp. Nov., 20: 225, 1924; 23: 335, 1927; Hand.-Maz., Symb. Sin., 7: 854, 1936. Franchet's type, "Yunnan, monte Li-kiang, 4000 m.s.m. (Delavay!)," has not been seen. Description and illustration distinctive.

Alpine meadows or open stony pastures, sometimes in shade near edge of forests, at altitudes of 2800 to 3900 meters, in northwestern Yunnan and adjacent southern Sikang. Flowers purple to purplish red. Flowering from June to August.

SIKANG: near Choso, *Schneider* 1594 (GH).

YUNNAN: no data, *Forrest* 28833 (ANSP), 30744 (ANSP), *Yü* 7265 (AA), 9074 (AA), 9611 (AA); Yen tse hay, *Delavay* s.n. (ANSP, UCLA); Likiang, *Schneider* 3620 (USNH); Likiang, Ta-chi on the Yangtze bank, *Ching* 21172 (AA); Likiang Snow Range, *Yü* 15421 (AA), *Ching* 30454 (AA); eastern slopes of Likiang Snow Range, *Forrest* 2780 (ANSP, UCLA), 6234 (UCLA), 7391 (UCLA), 27923 (ANSP), *Rock* 5023 (GH, USNH), 5287 (ANSP, UC, USNH), 5804 (NYBG, USNH), 9455 (USNH), 9917 (USNH); western slopes of Likiang Snow Range, *Rock* 5397 (USNH); Likiang Snow Range, Na Cho above Mahoang Patze, *Rock* 5949 (USNH); Likiang Snow Range, Haba Shan, *Rock* 24778 (CM, MBG, UC, UP, USNH), 25315 (UC); Chungtien, Laicatseka, *Feng* 1885 (AA).

This elegant species is distinctly characterized by its very large showy flowers with a beak. Fruits are found, together with flowers, on *Rock* 5949, 25315; they are compressed-ovoid, more or less pointed, about 2-2.5 cm. long and 1-1.2 cm. wide.

Series 20. Cyathophyllae ser. nov.

Low or tall plants; stems erect, simple or branching at base; leaves 4-verticillate, pinnatisect, the segments pinnatifid, denticulate, the base of the petioles and bracts greatly dilated and connate; calyx long-cylindric, glabrous or slightly hairy, reticulate or not, 2-dentate; corolla-tube long-cylindric, slender, 2-4 times as long as the calyx; galea more or less erect to strongly deflexed, glabrous to finely puberulous, with a distinct long slender beak; lower lip very broad, the lobes rounded, the margins finely ciliate, the middle lobe as large as the lateral ones; all staminal filaments hairy or 2 of them glabrous.

Two species in southeastern Sikang and northwestern Yunnan (Map 11).

Key to the Species

A. Calyx sparsely reticulate; corolla-tube up to twice as long as the calyx-tube; galea more or less erect, the beak pointing downward; 2 of the staminal filaments hairy. 80. *P. connata*

AA. Calyx not reticulate; corolla-tube over 3 times as long as the calyx-tube; galea strongly bent, the beak curved inward; all staminal filaments hairy. 81. *P. cyathophylla*

80. Pedicularis connata sp. nov. Plate 20, fig. 63.

Perennis; caulibus erectis, circiter 3-4 dm. altis, ad basim valde ramosis, sparse hirsutis vel glabrescentibus; foliis 4-verticillatis, inferioribus interdum oppositis, petiolis circiter 4-5 cm. longis, gracilibus, ad basim valde

dilatatis ad 1.5 cm. connatis, inferioribus interdum plus minusve liberis, laminā amplā, membranaceā, glabrā vel fere glabrā, oblongo-lanceolatā, apice attenuatā, obtusā, infra graciliter reticulatā, 9-11 cm. longā, 2.5-3 cm. latā, pinnatisectā, rhachidibus leviter alatis, segmentis utrinsecus 8-11, oblongo-lanceolatis, 1-1.5 cm. longis, 4-7 mm. latis, duplicato-dentatis vel lobatis; bracteis foliaceis, lanceolatis, acuminatis, superne saepe dentatis; floribus axillaribus, sparse dispositis; pedicellis 1-2 mm. longis; calyce cylindrico, circiter 1.5 cm. longo 2 mm. lato, nervis leviter hirsutis, graciliter reticulatis, tubo antice ad ⅓ fisso, margine 2-dentato, dentibus oblongo-lanceolatis, circiter 7-8 mm. longis, dentatis; corollā luteā, glaberrimā: tubo cylindrico, 1.7-2 cm. longo, erecto, apicem versus valde leviter dilatato; galeā 10 mm. longā, inferne plus minusve erectā, valde ampliatā (antheris inclusis), inde abrupte decurvā, porrectā, gradatim in rostrum productā, rostro gracili, decurvo, 5-6 mm. longo; labio inferiore 15-18 mm. longo, 3-lobato, lobis rotundatis, lobo medio sat parvo; filamentis anterioribus apicem versus leviter pilosis, inferioribus omnino glabris, antheris glabris, loculis basi subacutis; capsulis ignotis.

Type, in forests in valley, at an altitude of 4150 meters, in mountains between the Litang and Chou-chu Rivers, between Wa-Erh-Dje and Garu, Sikang Province, collected in flower, Aug. 1928, by J. F. Rock, No. 16742; holotype in the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium. A specimen in the Edinburgh Herbarium, Kingdon Ward s.n. and without data, also belongs to this species.

On the label of Rock's collection, the flowers are indicated as yellow. But apparently they are purple, as indicated by Dr. Pennell on the herbarium sheets that the corolla was purple and the color still persisted when he examined them in 1941. The purple tinge is still very evident now. However, it may be that the purplish tinge has developed from yellow color on drying.

This species is somewhat intermediate in characters between *P. superba* and *P. cyathophylla*. These three species all have connate petioles and beaked corolla. *P. superba* has short corolla-tube, which is dilated at the apex. *P. connata* has a longer and more slender corolla-tube. *P. cyathophylla* has the longest corolla-tube among the three species. The beak of *P. connata* is longer and narrower and more strongly curved than in *P. superba* but much less so than in *P. cyathophylla*. In the narrow, cylindric, and anteriorly cleft calyx with its two foliaceous lobes, *P. connata* resembles *P. cyathophylla*.

81. **Pedicularis cyathophylla** Franchet Plate 20, fig. 64.

Pedicularis cyathophylla Franch., in Bull. Soc. Bot. France, 47: 25, 1900; Limpricht, in Repert. Sp. Nov., 20: 225, 1924. Franchet's type, "Su-tchuen, autour de Tatsien-lou et de Tche-to-chan (Soulié, n. 218)," has not been seen. The type locality is now known as Kanting, Sikang Province. Description distinctive.

Alpine meadows at an altitude of about 4700 meters in southeastern and eastern Sikang and northwestern Yunnan. Flowers purple. Flowering from June through August.

SIKANG: Vallée de Lotror, *Soulié* 2843 (B); Litang-Yalung divide, *Ward* 4423 (RBGE); Mount Konka, Risonquemba, Konkaling, *Rock* 16402 (ANSP, USNH), 16407 (ANSP, USNH); mountains between the Litang and Yalung Rivers, between Muli Gomba and Baurong and Wa-Erh-Dje, *Rock* 16636 (ANSP, USNH); between Baurong and Kulu, west of the Yalung River, *Rock* 17825a (USNH); eastern Muli, Dzampe sheren mountain, west of Wuato Gomba, *Rock* 23763 (CM, NYBG, UC, UP, USNH), 24329 (NYBG, UC, UP, USNH).

YUNNAN: no precise locality, *Yü* 6547 (AA).

This is a unique species with distinctly dilated and connate petioles and long-tubular as well as beaked corolla. Franchet originally described the calyx as "oblongus, glaber, antice fissus, 5-dentatus, dentibus 4 anticis minimis, posteriore multo majore foliacea, integra." It is found, however, that most specimens have two large lateral lobes that are either serrate or entire, and practically obscured posterior lobes. The staminal filaments, not noted by Franchet, are all hairy distally. *Rock* 16636 and 24329 are mature fruiting specimens undoubtedly representing this same species. The fruit is oblong-ovoid, more or less compressed, caudate-acuminate, about 2.5 cm. long and 1.5 cm. wide, and opening on the inner side.

SECTION V. MACROCLADUS

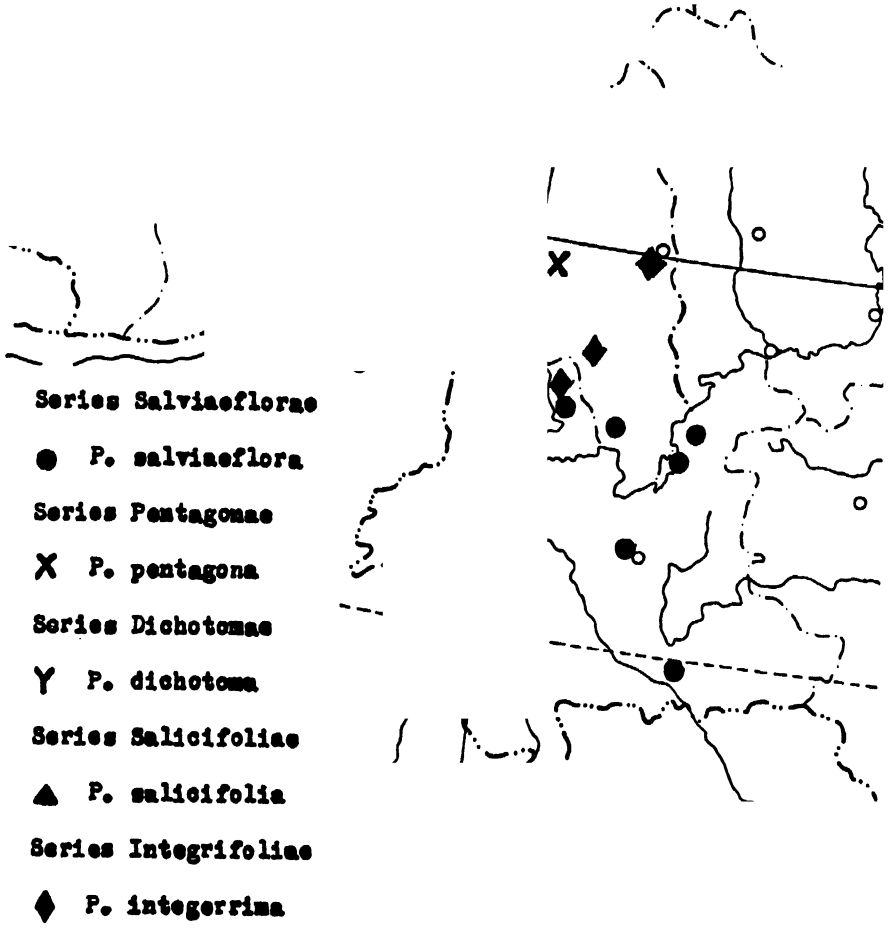
Erect or trailing plants, the stems freely branched, the branches spreading, slender, often somewhat trailing, pubescent; leaves opposite, distinctly petiolate, pinnatisect, the segments ovate-lanceolate, serrate; bracts serrate; flowers very large, scattered or loosely racemose, pedicellate; calyx campanulate, 5-dentate; corolla rose to red, the tube about twice as long as the calyx, slightly enlarged distally, slightly pubescent externally, pubescent internally; galea very long, erect, villose near the apex, occasionally with an insignificant deltoid tooth on each side of the lower margins; lower lip as long as the galea; staminal filaments all glabrous.

Pedicularis salviaeflora, the only species of this section, is distinct and suggests no close relationship with any other section. It is especially characterized by the opposite, much branched, strongly spreading and often trailing stems. The flowers are very large and arranged loosely in terminal racemes. In habit and loose disposition of the flowers this species resembles the group Poecilophyllum. Its distribution is limited to Yunnan and adjacent Szechuan.

Series 21. Salviaeflorae

Salviaeflorae Prain, in Ann. Bot. Gard. Calcutta, 3: 97, 1890.

The series has the characters of the section. It was created by Prain for *P. salviaeflora*. Another species, *P. imperialis* Franch., subsequently described, is now reduced to its synonymy. The series therefore contains a single species with its range limited to Yunnan and adjacent Szechuan (Map 12). The species, *P. salviaeflora*, is strongly characterized by its large size, with long, spreading, sometimes trailing branches, and the large, rather long reddish flowers.



Map 12.—Distribution of the series Salviaeflorae, Pentagonae, Dichotomae, Salicifoliae, and Integrifoliae.

82. Pedicularis salviaeflora Franchet Plate 21, fig. 65.

Pedicularis salviaeflora Franch. ex Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 215, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 90, 1911; 7: 163, 1912; 8: 43, 1913; 15: 150, 1926; Limpricht, in Repert. Sp. Nov., 20: 212, 1924; 23: 334, 1927; Pai, in Contr. Inst. Bot. Nat. Acad. Peiping, 2: 219, 1934; Hand.-Maz., Symb. Sin., 7: 50, 1936. Franchet's type was from: "Yunnan; in bushy places above Tapintse at 2000 meters (*Delavay*, 3123!). Herb. Kew." An isotype is in the Bonati Herbarium, to be divided between the University of California at Los Angeles and the Academy of Natural Sciences of Philadelphia.

Pedicularis imperialis Franch., in Bull. Soc. Bot. France, 47: 34, 1900; Limpricht, in Repert. Sp. Nov., 20: 212, 1924; Hand.-Maz., Symb. Sin., 7: 850, 1936. Franchet's type was from: "Yunnan, sur le Yo-lin-chan (Delavay, n. 6899)." Isotypes are in the herbarium of the University of California, the New York Botanical Garden, and the Bonati Herbarium. Franchet's two descriptions apparently represent two extreme forms of a single species, the true *P. salviaeflora* having thinner, larger, and more glabrous leaves, and *P. imperialis* having firmer, smaller, and more hairy leaves. Franchet did not state any difference in the floral characters. With a large series of specimens before me, I am convinced that all pertain to a single variable species. The leaves vary considerably in size, from 2 to 10 cm. in length, sometimes up to 15 cm., and they may be either membranaceous or sometimes rigid, sparsely hirsute to almost glabrous, sometimes being scabrous above and densely villose beneath. The flower is more constant in structure and the only variation noted is that some corollas are more hairy and others less so on the outer surface. In his key of 1910 (in Bull. Soc. Bot. France, 57, Mém. 18: 31, 1910) Bonati distinguished the two species as: *P. imperialis* with corolla-tube villose externally, and *P. salviaeflora* with corolla-tube glabrous. But this character does not hold sufficiently. The calyx-lobes vary from entire to serrate. The flowers may be scattered or loosely arranged in racemes at the end of the branches. These various characters correlate too little with each other or with different geographical ranges to warrant any specific or varietal differentiation.

In forests or on open grassy slopes at altitudes of 2000 to 3900 meters, in Yunnan from the south to the north and in adjacent Sikang. Flowers pink to purplish red. Flowering from June through October.

WESTERN CHINA: without precise locality, *Wilson* 4262 (B).

SIKANG: Yien-pien District, *Yü* 1704 (AA); Muli, *Forrest* 28382 (ANSP), *Ward* 4514 (RBGE).

YUNNAN: Tapintse, *Delavay* 3123 (ANSP, UCLA); Yo-lin-chan, *Delavay* 6899 (ANSP, NYBG, UC, UCLA); Kou-toui, *Delavay* s.n. (UCLA); Pan-lon-se, *Maire* 3248 (ANSP, UCLA, USNH); Pan-pien-kai, *Maire* s.n. (ANSP, UCLA); Tong Tchouan, *Maire* s.n. (UCLA), 3275 (ANSP, UCLA), 6368a (ANSP, UCLA); Yunnan sen, *Maire* 1338 (UC), *Ducloux* 698 (ANSP, UCLA), 789 (ANSP, UCLA), 918 (ANSP, UCLA, USNH); Tong Shan in the Yangtse bend, *Forrest* 10813 (ANSP, UCLA); Likiang, *Schneider* 3460 (USNH), *Forrest* 27930 (ANSP), *Ching* 21797 (AA); eastern slopes of Likiang Snow Range, *Forrest* 6348 (UCLA), *Rock* 5754 (ANSP, UC, USNH); between Tali and Likiang, *Handel-Mazzetti* 8519 (USNH); Youngning Territory, Mt. Wuaha, *Rock* 24213 (UC, UP); Chungtien, *Handel-Mazzetti* 4581 (USNH), 7685 (GH), *Feng* 2019 (AA); northeastern flank of Haba Snow Range, *Feng* 1297 (AA); Chio-kia District, *Tsai* 52027 (AA); Mengtze, *Henry* 9282 (MBG, NYBG), 9282 A (USNH), 9822 (NYBG), 9822 A (MBG, USNH); Kun-ming, *How* 74246 (AA); no precise locality, *Forrest* 28736 (ANSP).

SECTION VI. POLYSCHISTOPHYLLUM

Low or medium-sized plants; stems simple or dichotomously branched; leaves opposite, linearly pinnatisect, the segments distant, linear, pinnatisect to serrate, the petioles and rachis winged; flowers opposite, laxly racemose; bracts dilated proximally, serrate distally; calyx inflated, oblong-ovoid, strongly 5-angled, finely reticulate, 5-dentate, the teeth deltoid, entire; corolla-tube erect; galea with a distinct or obscure tooth on each side of the lower margins, the apex acute or prolonged into a very long slender beak; middle lobe of the lower lip smaller and more distad; filaments all hairy.

The two series of this section form a very natural group. They are strongly characterized by the strictly opposite linearly dissected leaves and the inflated, 5-angled, finely reticulate calyx. One of the species has a beakless galea while the other has a long slender beak. The section is probably related to some extent with certain species of the Orthosiphonia, such as *P. alaschanica* of the Myriophyllae, which it resembles somewhat in general appearance. The species of this section are found in northwestern Yunnan and southern and eastern Sikang.

Series 22. Pentagonae ser. nov.

Perennial, low or medium-sized plants; roots much thickened, fascicled; stems often branched; leaves opposite, linearly pinnatisect, the segments linear, distant, pinnatisect or serrate, the petioles and rachis winged; flowers opposite, laxly arranged in terminal racemes; bracts much dilated proximally and entire, linear distally and pinnatisect or irregularly serrate; calyx inflated, oblong-ovoid, strongly 5-angled, ciliate along the 5 main nerves, finely reticulate, 5-dentate, the teeth deltoid, entire; corolla purple: tube erect below, slightly bent distally; galea half as long as the lower lip, rounded in front, with one tooth on each side of the lower margin; lobes of the lower lip with fimbriate margins, the middle one smaller and more distad; filaments all hairy.

One species in southern Sikang and northwestern Yunnan (Map 12).

The relationship of this series is clearly with that of *P. dichotoma*. The latter has beaked corolla and is evidently evolved from species like this beakless one, as they agree closely in practically all other essential characters.

83. Pedicularis pentagona sp. nov. Plate 21, fig. 66.

Perennis; radicibus pluribus fasciculatis crassis longis; caulibus erectis, puberulis vel subglabris, ad 3 dm. longis, simplicibus vel ramosis; foliis oppositis, caulinis, longe petiolatis (petiolis circiter 1 cm. longis, distincte alatis, margine minute ciliatis), utrinque glabris, lineari-pinnatisectis, rhachidibus alatis, 2-3 mm. latis, margine irregulariter serratis, segmentis utrinsecus 4-7, remotis, linearibus acutis, inferioribus longis, ad 1.6 cm. longis 2-3 mm. latis, margine irregulariter serratis vel interdum lineari-dissectis, superioribus parvis, 2-5 mm. longis, irregulariter serratis; inflorescentiis spicatis terminalibus, ad 8 cm. longis; floribus laxis oppositis, plus minusve disjunctis; bracteis lineari-oblongis, ad 2 cm. longis, superne linearibus acutis, 2-3 mm. latis, pinnatifidis vel irregulariter serratis, utrinque glabris, inferne valde dilatatis, ovatis, 5-6 mm. latis, integris, margine costaque dense ciliatis; pedicellis circiter 1 mm. longis; calyce magno, inflato, oblongo-ovoideo, membranaceo, 8-9 mm. longo et 5-6 mm. lato, profunde 5-angulari, nervis principalibus 5, ciliatis, cum nervis 5 gracilibus alternis, graciliter reticulatis, dentibus 5, oblongo-triangularibus, dente posteriore parvo, caeteris aequalibus, acuminatis, integris, margine ciliatis; corollā purpureā, circiter 2.5 cm. longā, omnino glabrā: tubo circiter 1.6 cm. longo, in calyce plus minusve recto, supra calycem leviter curvato, superne paulo ampliato; galeā circiter 5 mm. longā, plus minusve rectā, fronte rotundatā, apicē truncatā, margine inferiore utrinque 1-dentatā, dentibus minimis, distinctis; labio inferiore circiter 10 mm. longo, margine fimbriato, 3-lobato, lobo medio parvo, leviter truncato, porrecto; staminibus ad basim tubi insertis, filamentis basi apiceque hirsutis caeterum glabris, antheris contiguis; stylo leviter exserto; capsulis immaturis ovoideis, valde compressis, acuminatis, in sicco atris, calyce accrescente inclusis.

Type, in moist shady bank in valley, mountains between the Litang and Shouchu Rivers, between Wa-Erh-Dje and Geru, Muli Territory, Sikang Province, collected in flower, July-Aug. 1928, by J. F. Rock, No. 16907; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotype in the United States National Herbarium.

On dry slopes or moist shady banks in valley, in southern Sikang and northwestern Yunnan. Flowers purple. Flowering in July and August.

SIKANG: mountains between the Litang and Shou-chu Rivers, between Wa-Erh-Dje and Garu, *Rock* 16895 (USNH), 16907 (ANSP, USNH).

YUNNAN: no precise locality, *Yü* 12931 (AA).

Among the specimens cited above, *Rock* 16907 consists of branching specimens, while *Rock* 16895 and *Yü* 12931 are unbranched specimens, the latter also being much shorter. However, they undoubtedly represent the same species with the characteristic leaves, bracts and flowers. This unique plant possesses many striking characters, among which are: (1) the more or less fascicled and thickened roots; (2) the strictly opposite, linearly dissected leaves; (3) the large inflated calyx which is 5-angled, finely reticulate, and with 5 entire, deltoid teeth; and (4) the galea with one tooth on each side of the lower margin and only half as long as the lower lip.

Series 23. Dichotomae ser. nov.

Perennial; roots thickened, fascicled; stems dichotomously branched or not branched; leaves opposite, linearly pinnatisect, the segments distant, linear, pinnatifid or serrate, the petioles and rachis winged; flowers opposite, distantly arranged toward the upper part of the stem; bracts linear distally, pinnatisect or irregularly serrate, much dilated and entire proximally; calyx large, oblong-ovoid, strongly 5-angled, ciliate along the main nerves, finely reticulate, 5-dentate, the teeth deltoid, entire; corolla rose to purple: tube erect; galea curved distally, with one obscure tooth on each side of the lower margins, the apex produced into a very long slender beak; beak more or less straight and horizontal; lower lip with margins glabrous, the middle lobe smaller and more distad; filaments all hairy.

One species in northwestern Yunnan and eastern Sikang (Map 12).

Pedicularis dichotoma was originally included in the series Pectinatae. It is such a distinct and characteristic species that a separate series is necessary for its accommodation. Its strictly opposite leaves, which are linearly dissected, are very distinctive. The 5-angled calyx with its fine reticulations and the large, much dilated bracts are also very characteristic. Its real relation is with *P. pentagona* which it closely resembles in practically all respects, except that the latter has a beakless corolla.

84. Pedicularis dichotoma Bonati Plate 21, fig. 67.

Pedicularis dichotoma Bonati, in Bull. Soc. Bot. France, 55: 247, 1908; Limpricht, in Repert. Sp. Nov., 20: 263, 1924. The type, "Yargong (*R. P. Soulié*), n° 3764, 1904 (Herb. Mus. Paris)," has not been seen. The type locality is in Sikang. The description is distinctive.

Pedicularis dichotoma var. *wardiana* Bonati, in Notes Bot. Gard. Edinb., 13: 123, 1921; Limpricht, in Repert. Sp. Nov., 20: 263, 1924; Hand.-Maz., Symb. Sin., 7: 870, 1936. The types, "N.W. Yunnan: A-tun-tsu. Alt. 11-13,000 ft. Aug. 1913. F. Kingdon Ward. Nos. 950, 1070," have not been seen. Bonati said: "[This variety] differs from the type described in 1908 (Bull. Soc. Bot. Fr., lv, 247): (1) by the calyx split in front to a third of its length; (2) by the lobes of the calyx being shorter and not exceeding the fourth or fifth of the length of the tube, (3) by the hood sharply contracted into long and linear beak; (4) by the lower lip of the corolla having its edge glabrous or with very few hairs." These are all relative characters which I fail to make out among the specimens seen and which represent a larger series than Bonati observed. Handel-Mazzetti recognized this variety on the basis of *Handel-Mazzetti* 7734; this specimen, being available, is found to be virtually the same as the others which I consider as the typical form of the species.

Pedicularis dichotoma var. Staff Bot. Gard. Edinb., in Notes Bot. Gard. Edinb., 17: 65, 1929. This unnamed variety was based on *Forrest* 14389, identified by Bonati.

Open alpine pastures at altitudes of 3330 to 4270 meters, in northwestern Yunnan and eastern Sikang. Flowers rose to purple. Flowering from July through September.

Sikang: Tsa-wa-rung, Nar-jou, *C. W. Wang* 66483 (AA); Tsa-wa-rung, Dzer-nar, *C. W. Wang* 66504 (AA).

Yunnan: Chungtien, *Handel-Mazzetti* 7734 (GH), *Feng* 1948 (AA), *Yü* 13702 (AA); Bei-ma-shan, Mekong-Yangtze divide, *Forrest* 13174 (ANSP, UCLA), 14389 (UCLA); Atuntze, *C. W. Wang* 70278 (AA); no precise localities, *Yü* 13354 (AA), *Forrest* 30007 (ANSP).

Among the specimens cited *Yü* 13702 and *Wang* 70278 are fruiting specimens. The capsules, originally unknown, are dark brown in color, compressed-ovoid, about 1.7 cm. long and 8 mm. wide, acuminate, wholly or partly enclosed by the accrescent calyx. The seeds are grayish white.

This is a very distinct and striking species which is evidently closely related to *P. pentagona*. It is like the latter in the opposite linearly dissected leaves, large, membranaceous, 5-angled, finely reticulate calyx with 5 entire teeth, purplish corolla, and in the filaments being all hairy distally. It differs from the latter primarily in the beaked corolla and in the margins of the lower corolla-lip being entire instead of fimbriate.

Section VII. Holophyllum

Stems usually short, branching or simple; leaves radical or cauline, the cauline opposite, sessile, linear to lanceolate, entire to subentire or crenulate; inflorescences in terminal spikes; calyx more or less cylindric, cleft or not anteriorly, 5-dentate, the teeth equal or unequal, entire or crenulate; corolla with the tube equaling or exceeding the calyx in length, erect; galea with the apex truncate or produced into a slender, sigmoid beak; staminal filaments hairy.

The two series comprising this section are characterized by the very long, more or less lanceolate, entire to subentire or crenulate leaves. They are distinct from other groups of the genus and occupy a more or less isolated position. The range of this section extends from the eastern Himalayas to northwestern Yunnan and Sikang.

Series 24. Salicifoliae

Salicifoliae Bonati, in Bull. Soc. Bot. Genève II, 15: 112, 1923.

Erect, branching or simple; leaves sessile, opposite, lanceolate to linear, acute, entire or obscurely crenate toward the apex; flowers in terminal spikes, the lower bracts leaf-like, the upper bracts ovate, much dilated at base; calyx membranaceous, cylindric, 5-dentate, the lobes more or less equal, entire; corolla rose, glabrous, the tube about equaling the calyx in length, the galea linear, erect or slightly bending forward, the apex truncate, the lower lip longer than the galea, the lobes more or less rounded, the middle one slightly larger; staminal filaments villose toward both ends, glabrous in the middle.

Bonati simply indicated: " (Anodontae, alternifoliae) series nov.: '*Salicifolia*' " and gave no description. In his description of the species, however, he mentions clearly that the leaves are opposite. Limpricht (in Repert. Sp. Nov., 23: 333, 1927), apparently without actual access to the specimens, placed the series in " Anodontae alternifoliae." He also followed Bonati in citing *Forrest* 19994, which is a typographical error for 10994.

This series, consisting of a single species *P. salicifolia*, is strongly characterized by the opposite, linear to lanceolate, sessile, more or less entire leaves, the rose-colored and entirely glabrous corolla with the galea entire, and the lower lip broad and exceeding the galea in length. Bonati remarked (l.c., 109) :" Cette plante est fort intéressante et semble être la première espèce d'une série nouvelle. Elle a, à première vue, l'aspect d'un *Pterygiella,* mais elle appartient certainement au genre *Pedicularis;* ses feuilles rappellent celles des *Pedicularis lanceolata, mogollonica,* etc., mais la corolle est du type *anodonta.*" Geographically the series is limited to northwestern Yunnan (Map 12).

85. Pedicularis salicifolia Bonati Plate 21, fig. 68.

Pedicularis salicifolia Bonati, in Bull. Soc. Bot. Genève II, 15: 112, 1923; in Bull. Soc. Bot. France, 71: Sep.-Abdr. 20, 1924; Limpricht, in Repert. Sp. Nov., 23: 333, 1927; Hand.-Maz., Symb. Sin., 7: 849, 1936. Bonati's types were from Yunnan: "Yunnan thibetain. I. 'Mountains N.W. of Chun-Chuan, lat. 26 ° 50′, alt. 900 m. Plant of 10-16 inches. Flowers rose. Dry stony pasture on the margins of pine forests on ledges of cliffs.' George Forrest, No 13040, Jul. 1914.—II. 'Chun-Tien Plateau, lat. 27° 33′, alt. 10.000 plant of 9-20 inches. Flowers deep rose; open stony pasture,'—G. Forrest, No 19994, Sept. 1913." The last number is a typographical error. It is actually 10994. Fragments of this number are in the Bonati Herbarium, and will pass to the University of California at Los Angeles.

Open stony pastures, at altitudes of 900 to 3500 meters, in northwestern Yunnan. Flowers rose. Flowering from July to September.

YUNNAN: Chung-tien Plateau, *Forrest* 10994 (UCLA); Tomannyu, King Tsai Ku, Region of Tungshan, Yangtze drainage basin, east of Likiang, *Rock* 10496 (ANSP).

This species was originally described as branched, but Handel-Mazzetti noticed (l.c.) that the specimens he collected were all unbranched. Bonati also described the corolla-tube as slightly shorter than, and included in, the calyx-tube. Observation shows that the corolla-tube actually about equals the calyx-tube in length or sometimes slightly exceeds it. The galea may be either erect or bending.

Series 25. Integrifoliae

Integrifoliae Prain, in Ann. Bot. Gard. Calcutta, 3: 70, 1890.

Low perennials with thick roots; stems many-fascicled, unbranched above, divaricate below, pubescent; leaves radical and cauline, the cauline strictly opposite, sessile, oblong- to linear-lanceolate, entire to subentire or crenulate; bracts foliaceous; calyx coriaceous, cylindric-campanulate, cleft anteriorly, 5-dentate, the teeth unequal, ovate to oblong, crenulate; corolla purple, the tube erect, longer than the calyx, the galea produced into a long slender sigmoid beak, the lower lip glabrous on the margins; all staminal filaments hairy throughout.

Two species, one in eastern Himalaya, and the other in northwestern Yunnan and Sikang (Map 12).

A very striking series with strictly opposite, lanceolate leaves which are entire to subentire or crenulate. The corolla is characteristically provided with a long, slender, sigmoid beak. This series suggests little relationship with other groups and is somewhat isolated in the genus.

86. Pedicularis integerrima Pennell & Li, sp. nov. Plate 21, fig. 69.

"*Pedicularis integrifolia*" *sensu* Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 210, 1890; Bonati, in Bull. Herb. Boiss. II, 7: 544, 1907; in Notes Bot. Gard. Edinb., 15: 168, 1926; Limpricht, in Repert. Sp. Nov., 20: 264, 1924, p.p.; 23: 339, 1927; Marquand & Shaw, in Journ. Linn. Soc. Bot., 48: 212, 1929; Pai, in Contr. Inst. Nat. Acad. Peiping, 2: 213, 1934; Hand.-Maz., Symb. Sin., 7: 871, 1936; *non* Hook. f. Hooker's species was described from, "Sikkim Himalaya." Maximowicz in 1888 (in Bull. Acad. St. Pétersb., 32: 545, fig. 23, 1888; in Mél. Biol., 12: 811, fig. 23, 1888) illustrated the species from specimens from Sikkim and southern Tibet. The Chinese plants which subsequent authors credited to *P. integrifolia* are different from the species of the eastern Himalayas.

Perennis; radice valde crassā, cylindricā; caulibus multis fasciculatis, divaricatis, superne adscendentibus, rectis, 10-20 cm. altis, hirsutis, 2-3-nodis; foliis radicalibus numerosis, sessilibus, lineari-lanceolatis, ad 10 cm. et ultra longis, circiter 4-8 mm. latis, utrinque glabris vel sparse hirsutis, apice acutis, basi longe attenuatis, margine plerumque integris interdum obscure crenato-serratis, saepissime revolutis, nervis secondariis utrinsecus 1 vel 2, cum costā parallelis, reticulatis; inflorescentiis terminalibus 5-8 cm. longis, fasciculis superioribus compactis, inferioribus distantibus; bracteïs foliaceis, ovato-oblongis vel oblongo-lanceolatis, calycem aequantibus vel 1½-plo longioribus, margine integris vel obscure crenato-serrulatis interdum ciliatis; pedicellis 3-5 mm. longis; calyce oblongo-ovoideo, circiter 1.2-1.5

cm. longo, 7-8 mm. lato, 10-costato ad venis hirsuto, distaliter reticulato, antice leviter fisso, dentibus 5, inaequalibus, uno posteriore plerumque parvo, caeteris ovatis, circiter 3-4 mm. longis, obtusis, margine obscure crenulatis, valde revolutis; corollā purpureā, 2.5-3 cm. longā: tubo gracili erecto, calycem superante, circiter 1.7-2 cm. longo; galeā circiter 0.8-1 cm. longā, inferne rectā, superne incurvatā, apice gradatim in rostrum productā; rostro sigmoideo, gracile, circiter 1.5 cm. longo; labio inferiore 1.2 cm. longo, 3-lobato, lobis rotundatis, integris, lobo medio sub-porrecto; staminibus ad medium tubi insertis, filamentis omnino hirsutis, antheris oblongis; stylo paulo exserto; capsulis ovoideis, compressis, in calyce inclusis, circiter 1.5 cm. longis et 8 mm. latis, apice obtusis.

Type, at altitudes of 3050 to 3500 meters, eastern slopes of Likiang Snow Range, Yunnan, collected in flower, May-October, 1922, by J. F. Rock, No. 3797; holotype in the herbarium of the Academy of Natural Sciences of Philadelphia; isotypes in the Gray Herbarium, the herbarium of the University of California, and the United States National Herbarium.

Alpine, limy meadows, or in fir forests, at altitudes of 2700 to 4000 meters, in northwestern Yunnan and Sikang. Flowers purple to purplish red. Flowering from May to July.

WESTERN CHINA: without precise locality, *Wilson* 4230 (UCLA).

SIKANG: Ta-tsien-lou, *Pratt* 589 (Dehra Dun), *Soulié* s.n. (UCLA); Litang-Yalung divide, *Ward* 4360 (RBGE); Mt. Mitzuga, Muli Territory, *Rock* 18244 (ANSP, USNH); Muli, Kulu, Tungyehtze, *Yü* 14337 (AA).

YUNNAN: Koualapo, near Hokin, *Delavay* 2153 (NYBG, UCLA); Likiang Snow Range, *Schneider* 1887 (USNH), 1935 (USNH), 3263 (GH), *Forrest* 10129 (ANSP, UC), 10150 (ANSP, UC), *Ching* 30178 (AA); eastern slopes of the Likiang Snow Range, *Rock* 3797 (ANSP, GH, UC, USNH), 4922 (NYBG, USNH), 5443 (CM, MBG, USNH), 8690 (USNH); Mt. Wuaha, Youngning Territory, *Rock* 24226 (CM, MBG, NYBG, UC, UP, USNH); Mt. Gyi-na lo-ko, Yu-lung Shan, *Rock* 25001 (NYBG, UC, UP, USNH); Atuntze, *Forrest* 19855 (UCLA), *C. W. Wang* 70107 (AA); Chungtien Valley, *Yü* 13606 (AA), 13616 (AA), *Feng* 1668 (AA), 1946 (AA); no precise localities, *Forrest* 28611 (ANSP, 28740 (ANSP), *Yü* 6341 AA), 7023 (AA), 12957 (AA).

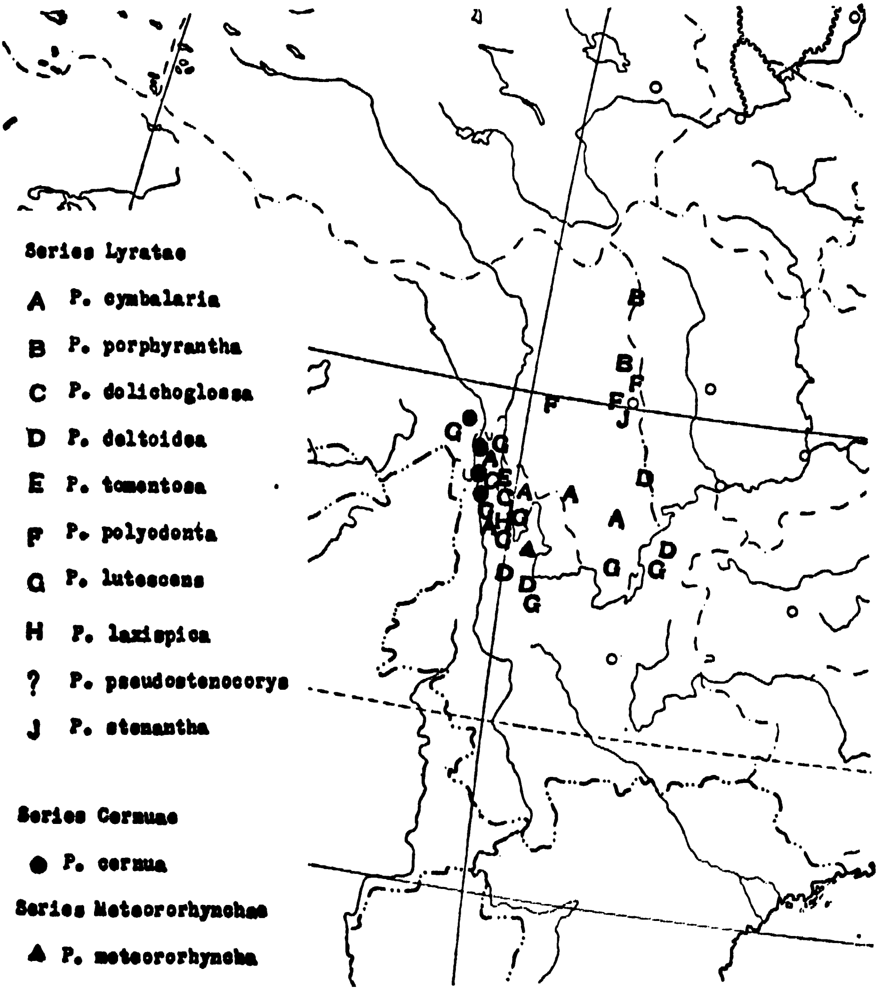
A very distinct species with opposite, lanceolate, almost entire leaves and long sigmoid beak. It is closely related to the eastern Himalayan *P. integrifolia* Hook. f., but the Chinese plant is clearly specifically distinct. It differs from the Indian plant in that it is larger, the stems are usually more numerous, taller, ascending and straight, the leaves are more nearly entire, the corollas are larger and with longer tube and less abruptly contracted galea. In *P. integrifolia* the stems are usually fewer, lower, spreading and widely prostrate and curving, and the leaves are usually distinctly crenately serrate.

SECTION VIII. BRACHYPHYLLUM

Usually low, rarely tall plants; stems single or several together, simple; leaves opposite or rarely ternate, sessile or very short-petiolate, rarely long-petiolate, broad, pinnatifid to palmatifid, rarely pinnatisect to palmatisect; inflorescences short or long, spicate or racemose; calyx campanulate, not, or

only very slightly, cleft anteriorly, 5-dentate, the teeth equal to unequal, entire to serrate; corolla erect, the tube equal to, or longer than, the calyx; galea with the apex either bidentate or beaked.

This section, together with Dolichophyllum, represent opposite-leaved groups that show an occasional tendency to bear ternate leaves. They are apparently intermediate between opposite and verticillate-leaved groups. Brachyphyllum, as compared with Dolichophyllum, has smaller leaves, which are less dissected and shorter-petiolate, with few of them radical. Dolichophyllum, on the other hand, is taller and with larger, more dissected



Map. 13.—Distribution of the series Lyratae, Cernuae, and Meteororhynchae.

and longer petiolate leaves. The section has a range extending from the eastern Himalayas to western China.

Series 26. Lyratae

Lyratae Maxim., in Bull. Acad. St. Pétersb., 32: 603, 1888; in Mél. Biol., 12: 869, 1888.

Low perennials, branching or simple; leaves usually opposite, occasionally 3- or rarely 4-verticillate, sessile to short-petiolate, the radicals long-petiolate, generally ovate-oblong, pinnatifid, rarely deltoid to subpalmately lobed, the lobes pinnatifid to serrate or crenulate; calyx campanulate, the teeth lanceolate to deltoid; corolla yellow to rose, or purple, the tube erect, equal to or usually longer than the calyx, the galea longer than the lower lip, erect proximally to slightly bending distally, rounded in front or slightly pointed, the apex truncate, with 1 or several teeth on each side of the lower margins; filaments all glabrous or 2 of them hairy.

About 11 species from the eastern Himalayas to western China (Map 13).

This series when first established by Maximowicz contained four species: *P. melampyriflora*, *P. deltoidea*, *P. lutescens*, and *P. lyrata* Prain. Prain in 1890 (in Ann. Bot. Gard. Calcutta, 3: 85, 1890) removed *P. melampyriflora* from this series to form the series Melampyriflorae. In 1910 Bonati (in Bull. Soc. Bot. France, 57, Mém. 18: 28-29, 1910), separated *P. lutescens* to form the series Ternatae, but later (in Notes Bot. Gard. Edinb., 13: 137, 1921), admitting this as an error, combined the two series. He included 6 species in his key to those of the series. These same 6 species were listed by Limpricht (in Repert. Sp. Nov., 20: 226, 1924), who also added *P. stenantha* Franch. (1891) to the list.

Key to the Chinese Species

A. Plant creeping; corolla rose or pale yellow; galea with 1 tooth on each side of the lower margin; all staminal filaments glabrous. .... 87. *P. cymbalaria*

AA. Plants erect; corolla red, purple, or yellow; galea with 1 or several teeth on each side of the lower margin; staminal filaments all glabrous or two of them hairy.

- B. Galea rounded at apex, not pointed or acute; lower lip of corolla with rounded middle lobes.
  - C. Galea with a small protuberance near the middle of each lower margin; lower lip very broad, the lobes equal, the middle one slightly distad. 88. *P. porphyrantha*
  - CC. Galea without a protuberance near the middle of each lower margin; lower lip narrower, the lobes unequal, the middle lobe either larger or smaller than the lateral, very distad.
    - D. Middle lobe of the lower lip smaller than the laterals; margins of the lower lip ciliate; galea very long, slightly bending distally. 89. *P. dolichoglossa*
    - DD. Middle lobe of the lower lip larger than the laterals; margins of the lower lip fimbriate or entire, not ciliate; galea relatively shorter, more bending distally.
      - E. Galea with usually 1 tooth on each side of the lower margins.
        - F. Corolla red, about 2 cm. or less long; margins of the lower lip usually entire. .... 90. *P. deltoidea*

FF. Corolla yellow with purplish dots, about 2.3 cm. long; margins of the lower lip fimbriate. ... 91. *P. tomentosa*

EE. Galea with several teeth on each side of the lower margins. 92. *P. polyodonta*

BB. Galea acute or pointed at apex; lower lip of corolla with emarginate middle lobe.

C. Plant pubescent; leaves pinnately lobed; galea with several teeth on each side of the lower margins; staminal filaments all glabrous.

D. Plant with more or less compactly arranged flowers; corolla-tube about as long as the calyx; calyx not cleft anteriorly. 93. *P. lutescens*

DD. Plant with laxly arranged flowers; corolla-tube about 1½ times as long as the calyx; calyx very slightly cleft anteriorly. 94. *P. laxispica*

CC. Plant glabrous; leaves pinnatisect; galea with 1 tooth on each side of the lower margin; 2 of the staminal filaments hairy. 95. *P. pseudostenocorys*

Status uncertain. .... 96. *P. stenantha*

87. Pedicularis cymbalaria Bonati Plate 21, fig. 70.

Pedicularis cymbalaria Bonati, Gen. Pedicularis, 71, 112, 1918; in obs.; in Notes Bot. Gard. Edinb., 13: 136, 1921; Limpricht, in Repert. Sp. Nov., 20: 226, 1924; Staff Bot. Gard. Edinb., in Notes Bot. Gard. Edinb., 17: 80, 1929; Hand.-Maz., Symb. Sin., 7: 855, 1926. Bonati's original types were from Yunnan and Sikang: "'West China:—Moist, stony pasture on the Mekong-Salween divide, Yunnan. Lat 28° 10′ N. Alt. 13,000 ft. Plant of 2-3 ins. Flowers pale rose. August 1914.' G. Forrest. No. 13,222. 'S.E. Tibet:—On moist, shady banks in pine forest on Ka-gwr-pw, Mekong-Salween divide, Tsarong. Lat. 28° 30′ N. Alt. 11,000 ft. Plant of 4-6 ins. Flower light blue. August, 1914.' G. Forrest. No. 14,582." Several sheets of *Forrest* 13222 are found in the Bonati Herbarium together with Bonati's brief description and notes in his handwriting, thus constituting it his type; the actual type and note remain at the Academy of Natural Sciences of Philadelphia, with isotype at the University of California at Los Angeles. One sheet of *Forrest 14582* is also found. These are evidently the specimens on which the original description was drawn.

In open moist stony meadows or on shady banks, at altitudes of 3400 to 4000 meters, in northern Yunnan and southeastern Sikang. Flowers rose. Flowering in August.

SIKANG: mountains southwest of Muli, *Forrest* 22143 (USNH); between Yenyüen and the Yalung River, *Handel-Mazzetti* 5417 (USNH); between Muli and Yung-ning, *Ward* 4802 (RBGE).

YUNNAN: no locality, *Yü* 12751 (AA); Mekong-Salween divide, *Forrest* 13222 (ANSP, UCLA), 14582 (ANSP, UCLA); A-tun-tse, Bei-mar-shan, *C. W. Wang* 69457 (AA); Chungtien, *Feng* 1984 (AA).

A distinct semi-prostrate plant. *Handel-Mazzetti* 5417 bears both flowers and fruits. *Wang* 69457 is a mature fruiting specimen. The fruits are erect, sharply pointed, about 1-1.2 cm. long and 4-5 mm. wide. In most cases, the flowers are recorded as rose or pale rose. The label of *Forrest* 14582 states, " flowers light blue " and that of *Forrest* 22143, " flowers pale yellow, almost white."

88. Pedicularis porphyrantha sp. nov. Plate 21, fig. 71.

Perennis (?), caule simplice vel ramosā, circiter 20 cm. altā, glabratā vel sparse hirsutā; foliis caulinis, 4-verticillatis, petiolatis (petiolis 0.8-1.5 cm.

longis, sparse hirsutis, haud alatis), oblongo-lanceolatis, circiter 3 cm. longis 8 mm. latis, utrinque glabris, supra atro-purpureis, subtus viridibus, apice obtusis, pinnatisectis, vel profunde pinnatifidis, rhachidibus 1 mm. latis, segmentis utrinsecus circiter 10, ovatis, circiter 3.5 mm. longis et 3 mm. latis, pinnatifidis, dentatis; inflorescentiis spicatis terminalibus, circiter 3 cm. longis, floribus compactis; bracteis foliaceis, oblongo-lanceolatis, profunde pinnatifidis, calycem superantibus; pedicellis 1 mm. longis; calycibus ovatis, membranaceis, sparse hirsutis, 10-costatis, haud reticulatis vel ad marginem vix reticulatis, 5-dentatis, dente uno deltoideo, brevi, caeteris ovatis, 2 mm. longis, ad basim contractis, superne pinnatifidis dentatis; corollā purpureā, circiter 2.5 cm. longā, omnino glabrā: tubo circiter 1 cm. longo, in calyce recto, superne paulo ampliato; galeā circiter 1.5 cm. longā, plus minusve rectā, ad medium paulo deflexā, margine inferiore ad medium versus leviter protrusā, fronte rotundatā, apice truncatā, margine 1-dentatā, dentibus linearibus gracilibus longe acuminatis; labio inferiore galeam aequante, valde lato, lobis plus minusve aequalibus rotundatis, integris, lobo medio sub-porrecto; staminibus ad basim tubi insertis; filamentis totis glabris, antheris plus minusve contiguis, loculis basi acutis; stylis valde exsertis; capsulis ignotis.

Type, in grassland, at an altitude of about 3660 meters, Lieng-ho-kou, Sikang, collected in flower, Aug. 1938, by T. K. Wang & T. S. Wen, No. 610; holotype in the herbarium of the Arnold Arboretum. Flowers purple.

SIKANG: Lien-ho-kou, *Wang & Wen* 610 (AA); Baurong to Tachienlu, via Hadjaha, *Stevens* 527 (CM); Ta-tsien-lu, *Cunningham* 388 (RBGE).

A distinct species, evidently belonging to the series Lyratae. It is characterized by the relatively large, membranaceous calyx, with the teeth mostly ovate, conspicuous, and distinctly pinnatifid, the erect corolla which is slightly bent in the middle of the galea and with a small protuberance near the middle of the lower margins. In the last character as well as in the structure of the calyx and the long-exserted style, it suggests relationship with *P. cernua*. The species, however, differs considerably from the latter in its smaller habit, absence of radical leaves, its relatively broader lower lip with glabrous margins, the glabrous filaments, etc.

89. Pedicularis dolichoglossa sp. nov. Plate 22, fig. 72.

Planta nana, ad 7 cm. alta; radicibus fasciculatis, fibrosis; caulibus plerumque multis, infirmis, gracilibus, leviter pubescentibus, paucifoliatis; foliis radicalibus et caulinis, similibus, ad 3.5 cm. longis, longe petiolatis, petiolis gracilibus, ad 2.3 cm. longis, leviter pubescentibus, alatis, laminis ovatis vel ovato-oblongis, ad 1.6 cm. longis 8 mm. latis, membranaceis, glabrescentibus vel parce pubescentibus, apice obtusis, profunde pinnatifidis, segmentis utrinque 7-9, oblongis, ad 4 mm. longis 2 mm. latis, rotundatis, pinnatifidis; inflorescentiis terminalibus brevibus, multifloris, compactis, ad 3 cm. longis; floribus subsessilibus; bracteis calycem superantibus, pinnatifidis; calyce ovoideo-cylindrico, circiter 1 cm. longo 4 mm. lato, membranaceo, haud reticulato, sparse pubescente, 5-dentato, dentibus inaequalibus, dente posteriore deltoideo, acuto, integro, dentibus lateralibus oblongo-

ovatis, dentatis, basi leviter constrictis; corollā luteā (?), 2.3-2.5 cm. longā; tubo erecto, calycem superante; galeā erectā, ad 2 cm. longā, superne leviter curvatā, apice rotundatā, margine plerumque utrinque 1-dentatā; labio inferiore superius subaequante, margine sparse ciliato, lobis inaequalibus, lateralibus rotundatis, lobo medio parvo, porrecto, rotundato vel truncato; staminibus ad basim tubi insertis, filamentis glabris; stylo exserto; capsulis ignotis.

Type, in northwestern Yunnan, field data not available, collected in flower, in 1938, by T. T. Yü, No. 6924; holotype in the herbarium of the Arnold Arboretum. Flowers yellow with purple dots (?). Only collection seen.

This species is distinguished by the relatively long, slightly bending galea, the ciliate-margined lower lip, and by the middle lobe of the lower lip being smaller than the laterals. In general habit, it resembles *P. lutescens;* but it is readily distinguished from the latter, in addition to the characters mentioned above, in the galea being rounded at apex and with only 1 tooth on each side of the lower margin instead of pointed at apex and with several teeth on the margins.

90. **Pedicularis deltoidea** Franchet Plate 22, fig. 73.

Pedicularis deltoidea Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 604, fig. 133, 1888; in Mél. Biol., 12: 169, fig. 133, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 208, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 89, 1911; 7: 68, 241, 1912; Limpricht, in Repert. Sp. Nov., 20: 226, 1924; Hand.-Maz., Symb. Sin., 7: 855, 1936. Franchet's types were from: "Yunnan in lapidosis Tsangchan supra Tali, 3500 m.s.m., nec non montibus Koua-la-po prope Hokin, 3000 m.s.m. (Delavay. in herb. Paris)." Forbes & Hemsley cited these same localities for Delavay's collections. Limpricht listed *Delavay* s.n. for the first locality, "Tsang shan bei Talifu," and *Delavay* 963 for the second, "Koua la po bei Hokin." In the Bonati Herbarium there is a specimen from Yunnan, *Delavay* 197, from the Paris Museum, bearing the label: "*Pedicularis deltoidea* Franch. Fl. rouges. Pâturages au sommet du Yang in chan. V août 1883." As this is a much earlier number than *Delavay* 963, having been collected 1 Aug., 1883, it may be that this is one of the syntypes; it will be divided between the Academy of Natural Sciences of Philadelphia and the University of California at Los Angeles.

Open stony moist pastures at altitudes of 2600 to 3300 meters, in northern Yunnan and southeastern Sikang. Flowers rose. Flowering from August to September.

SIKANG: Si-chang District, *Yü* 1302 (GH).

YUNNAN: Yang in chan, *Delavay* 197 (ANSP, UCLA); Tsang yang tchan sur Mo so Yn, *Delavay* s.n. (UCLA); Ie-ma-tchouen, *Maire* 1034 (B); Tong-tchouan, *Maire* 3940 (ANSP, UCLA); Tali, *Schneider* 2512 (USNH); eastern flank of the Tali Range, *Forrest* 4490 (ANSP, UCLA); western flank of the Tali Range, *Forrest* 11560 (ANSP, UCLA); Che-tze-lo, *Tsai* 58575 (AA); no precise localities, *Tsoong* 2390 (UC), *Forrest* 28912 (ANSP).

91. **Pedicularis tomentosa** sp. nov. Plate 22, fig. 74.

Planta nana, ad 12 cm. alta, tomentosa; radicibus verticalibus, singulis, haud crassis; caulibus singulis vel basim versus ramosis, superne simplicibus vel breviter ramosis, foliatis; foliis oppositis, sessilibus, ovato-oblongis, ad

1.3 cm. longis 7 mm. latis, utrinque tomentosis, apice obtusis, circiter 2 mm. longis 1.5 mm. latis, rotundatis vel obtusis, subintegris vel obscure crenulatis, basi latis; inflorescentiis terminalibus, brevibus vel elongatis, paucifloris, ad 4 cm. longis; bracteis foliaceis, pinnatifidis, calycem subaequantibus vel paulo longioribus; floribus subsessilibus; calyce cylindrico, circiter 6 mm. longo 3 mm. lato, tomentoso, leviter reticulato, 5-dentato, dentibus inaequalibus, dente posteriore lineari-oblongo, subintegro, dentibus lateralibus ovato-oblongis, serratis; corollā luteā (?), circiter 2.2-2.5 cm. longā: tubo erecto calycem ½ plo longiore; galeā erectā, tubum subaequante, 1.2-1.3 cm. longa, superne curvatā, apice rotundatā, margine utrinque plerumque 1-dentatā; labio inferiore superius subaequante, margine glabro, 3-lobato, lobis rotundatis, lobo medio porrecto et majore; staminibus ad basim tubi insertis, filamentis glabris; stylo exserto; capsulis ignotis.

Type, in northwestern Yunnan, field data not available, collected in flower by T. T. Yü, No. 13112; holotype in the herbarium of the Arnold Arboretum. Flowers yellow with purple dots on the galea (?). Only collection seen.

The galea of this new species resembles that of *P. dolichoglossa* in being rounded in front and with 1 tooth on each of the lower margins. However, *P. tomentosa* has a glabrous lower lip with a larger, instead of smaller middle lobe. The two species also differ in habit.

92. Pedicularis polyodonta sp. nov. Plate 22, fig. 75.

"*Pedicularis lyrata*" *sensu* Franch., in Bull. Soc. Bot. France, 47: 33, 1900; Bonati, in Bull. Soc. Bot. France, 54: 186, 1907; in Bull. Herb. Boiss. II, 7: 545, 1907; Limpricht, in Repert. Sp. Nov., 20: 226, 1824, p.p.; *non* Prain.

Pedicularis lyrata var. *cordifolia* Franch., in Bull. Soc. Bot. France, 47: 33, 1900; Limpricht, in Repert. Sp. Nov., 20: 226, 1924. Franchet's type, "Yunnan, à Maeul-chan (Delavay)," has not been seen.

Perennis; caulibus erectis, circiter 10-12 cm. altis, totis pubescentibus, singulis plerumque ad basim ramosis, aliis simplicibus, ramulis plus minusve divaricatis; foliis oppositis vel ternatis, basalibus petiolatis (petiolis ad 1 cm. longis), caulinis subsessilibus vel breviter petiolatis (petiolis 2-4 mm. longis), ovato-lanceolatis, 1.0-2.3 cm. longis, 5-7 mm. latis, apice obtusis, margine profunde crenatis, utrinque pubescentibus; inflorescentiis spicatis terminalibus, floribus plus minusve compactis; bracteis ovato-oblongis, apice obtusis, margine crenatis, plerumque basim versus valde dilatatis; pedicellis 1-2 mm. longis; calyce tubuliformi, 1.2-1.5 cm. longo, pubescente, distincte 10-costato, lobis 1 vel 2 linearibus acutisque, circiter 1 cm. longo, recto; corollā pallide luteā circiter 2.2 cm. longā, omnino glabrā: tubo circiter 1 cm. longo, recto; galeā superne valde incurvatā, fronte rotundatā, āpice inferiore truncatā, margine inferiore utrinque 4-5-dentatā; labio inferiore 1 cm. longo, lobis rotundatis, margine denticulatis, lobo medio majore; staminibus ad basim tubi insertis, filamentis glabris, antheris glabris, loculis basi acutis; stylo exserto; capsulis ignotis.

Type, Kanting (Ta-tsien-lou), Sikang, collected by J. A. Soulié, No. 103; holotype, from the Bonati Herbarium, is at the Academy of Natural Sciences of Philadelphia.

Sikang: Ta-tsien-lou, *Soulié* 103 (ANSP); Tongolo, *Soulié* 379 (UCLA), 2861 (ANSP); Baurong to Tachienlu, via Hadjaha, *Stevens* 526 (CM).

Western China: without precise locality, *Wilson* 4252 (UCLA).

Asia: without precise locality, *Komarov* s.n. (ANSP, UCLA).

Franchet was the first to credit the Indian-Himalayan species *P. lyrata* Prain to western China. He cited the following specimens: "La Chine occidentale: Su-tchuen, autour de Ta-tsien-lou (n^{os} 306, 307, 302); Tongolo, sur les pelouses sèches (*Soulié* n^{os} 379, 103, 856)," all from Sikang. This was followed by Bonati, who added *Wilson* 252, and Limpricht, who added *Schneider* 2390, 3253, to the same species. However, Franchet when first crediting *P. lyrata* to western China, clearly indicated the differences between the Indian and Chinese plants. A comparison of Prain's type specimen (from Herb. Hort. Bot. Calcutta), his description and illustrations, together with the Chinese plants on hand, prove that two distinct species are represented.

This species, although resembling *P. lyrata*, differs from the latter in being a much larger plant, with elongated, erect stem, in the larger flowers with relatively shorter tube and with 4 or 5 teeth on the lower margins of the galea instead of 3 or 4. Moreover, the styles are distinctly exserted while in *P. lyrata* these are all included.

93. Pedicularis lutescens Franchet

This is a very variable species. The habit of the plant varies from rather tall and strict with erect simple stem to forms that are branched throughout or dwarfed with many divaricate branches from the base. The leaves are of different sizes and are either sessile to long-petiolate. However, the floral structures seem to be rather consistent and little variation therein can be noticed in the supposedly different varieties. The corolla is yellow or pale yellow, sometimes with purplish spots on the galea or on the lower lip or both. The extreme forms are here recognized as varieties, though intermediate states are occasionally noticed betwen them.

Key to the Varieties

A. Plants robust, tall, to 3 dm. or more high, simple or few-branched above, rarely branching at base, the branches erect; leaves large, 3 cm. or more long.

  B. Leaves distinctly petiolate, the petioles 8-10 mm. long; galea about 3.5 mm. broad, with 4-6 teeth along the lower margins on each side. .... 93a. *P. l. typica*

  BB. Leaves subsessile, the petioles hardly 2-3 mm. long; galea about 1.5-2 mm. broad, with 8-10 teeth along the lower margin on each side. 93b. *P. l. tongtchouanensis*

AA. Plants 2 dm. or less high, rarely to 3 dm., usually much branched at base, the branches often divaricate; leaves small, 2 cm. or less long.

  B. Plants low or tall, to 2 dm. high, the branches stout, rigid; leaves subsessile to short-petiolate, the petioles scarcely to 1 cm. long.

C. Plant usually few-branched at base; leaves subsessile, the petioles scarcely 2-3 mm. long. .... 93c. *P. l. brevifolia*
CC. Plant many-branched at base; leaves distinctly petiolate, the petioles about 5 mm., sometimes to 1 cm., long. .... 93d. *P. l. ramosa*
BB. Plant dwarf, up to 1 dm. high; branches slender; leaves long-petiolate, the lower ones 2-2.5 cm. long. .... 93e. *P. l. longipetiolata*

93a. Pedicularis lutescens typica Plate 22, fig. 76.

Pedicularis lutescens Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 605, fig. 134, 1888; in Mél. Biol., 12: 898, fig. 134, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 212, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 89, 1911; 7: 178, 242, 1912; 8: 42, 1913; Limpricht, in Repert. Sp. Nov., 20: 227, 1924; Hand.-Mazz., Symb. Sin., 7: 855, 1936. Franchet's type, "Yunnan, angustiis Yentze-hay supra Lan-kong, 3200 m.s.m. (Delavay!)," has not been seen. Limpricht gave this number as *Delavay* 2380. Two unnumbered specimens of Delavay are found in the Bonati Herbarium, one without data and the other collected from "Fang yang tchang" in July 1887. It is doubtful whether either of these can be referred to the type collection.

Pedicularis truchetii Bonati, in Notes Bot. Gard. Edinb., 15: 155, 1926; Limpricht, in Repert. Sp. Nov., 23: 335, 1927. Bonati's type was from: "'Yunnan: Na Cho, above the Mahoang Patse, Yangtze watershed, Prefectural District of Likiang, eastern slopes of Likiang Snow Range. 16,000 ft. Flowers yellow. Aug. 19, 1922.' J. F. Rock. No. 5913." An isotype is in the United States National Herbarium. It proves to be identical with *P. lutescens*.

Open alpine pastureland or in forests, at altitudes of 3500 to 4000 meters, in northwestern Yunnan. Flowers yellow. Flowering from June to August.

YUNNAN: no data, *Delavay* s.n. (UCLA), *Forrest* 30765 (ANSP); Fang yang tchang, Mo so yn, *Delavay* s.n. (ANSP, UCLA); eastern slope of the Tali Range, *Forrest* 4494 (UCLA); Chungtien, *Schneider* 3253 (GH, USNH); eastern flank of Likiang Snow Range, *Forrest* 2937 (UCLA), *Rock* 5810 (UC, USNH), 5913 (USNH); Lan-pin District, *Tsai* 53771 (AA); Che-tze-lo, Pi-lo-shan, *Tsai* 58015 (AA), 58254 (AA), 58286 (AA).

The corollas of most plants are wholly yellow but in a few flowers there are pinkish spots on the galea or on the lower lip or on both. *Rock* 5810 was cited by Bonati (in Notes Bot. Gard. Edinb., 15: 155, 1926) as representing his var. *brevifolia*. However, the two specimens seen by me clearly indicate the typical form of the species.

93b. Pedicularis lutescens tongtchouanensis Bonati

Pedicularis lutescens Franch. var. *tongtchouanensis* Bonati, in Notes Bot. Gard. Edinb., 13: 135, 1921; Limpricht, in Repert. Sp. Nov., 20: 227, 1924. Bonati's type, "E. Yunnan: Tong-tchouan, E. E. Maire," in the Bonati Herbarium, will pass to the University of California at Los Angeles, with isotype at the Academy of Natural Sciences of Philadelphia. The type locality is Tung-chuan, in northeastern Yunnan.

At an altitude of about 3700 meters, in northeastern Yunnan. Flowers yellow. Flowering in August.

YUNNAN: Tong-chuan, *Maire* s.n. (ANSP, UCLA); Plateau du Io-ch'an, *Maire* s.n. (ANSP, UCLA).

This variety appears to be very close to the typical form of the species, differing only in the shorter petiolate, more or less subsessile leaves and slightly narrower galea. There are generally many purplish dots on the lower lip of the corolla.

93c. Pedicularis lutescens brevifolia Bonati

Pedicularis lutescens Franch. var. *brevifolia* Bonati, in Notes Bot. Gard. Edinb., 13: 135, 1921; Limpricht, in Repert. Sp. Nov., 20: 227, 1924; Hand.-Maz., Symb. Sin., 7: 855, 1936. Bonati's type, "'Northern Yunnan. On stony pasture and in open pine forests on the N.W. flank of the Lichiang Range. Lat. 24° 30′ N. Alt. 11,000 ft. Plant of 3-5 ins. Flowers pale yellow. Aug. 1914.' G. Forrest. No. 13,028," as well as an isotype, are in the Bonati Herbarium; the type will pass to the University of California at Los Angeles, and the isotype to the Academy of Natural Sciences of Philadelphia.

Stony pastures and open pine forests, at an altitude of about 3350 meters, in northwestern Yunnan. Flowers yellow. Flowering in August.

YUNNAN: northwestern flank of the Likiang Snow Range, *Forrest* 13028 (ANSP, UCLA); no data, *Yü* 7570 (AA).

This is a rather hairy plant with small, ovate leaves, which are more or less sessile. The corolla is free from purple dots.

93d. Pedicularis lutescens ramosa Bonati

Pedicularis lutescens Franch. var. *ramosa* Bonati, in Notes Bot. Gard. Edinb., 13: 135, 1921; 15: 155, 1926; Limpricht, in Repert. Sp. Nov., 20: 227, 1924; 23: 335, 1927; Hand.-Maz., Symb. Sin., 7: 855, 1936. Bonati's type, "'West China:—Marshy, stony pasture on the mountains in the N. E. of the Yangtze Bend, Yunnan, Lat. 24° 45′ N. Alt. 11,000-12,000 ft. Plant of 2-4 ins. Flowers yellow. August 1913.' G. Forrest. No. 10,775," from the Bonati Herbarium, passes to the Academy of Natural Sciences of Philadelphia. An isotype is in the herbarium of the University of California.

Marshy, stony pastures, at altitudes of 2800 to 4800 meters, in northwestern Yunnan and southern Sikang. Flowers yellow. Flowering in late July, August, and September.

SIKANG: Hui-li District, *Yü* 1601 (AA); Litang-Yalung divide, *Ward* 4361 (RBGE); Mu-li, *Ward* 4795 (RBGE).

YUNNAN: northwestern Yunnan, northeast of the Yangtse bend, *Forrest* 10775 (ANSP, UC); Chungtien, *Schneider* 2390 (B); south of Chungtien, Kung-shiang-shu Snow Mountain, *Feng* 1757 (AA); eastern slope of the Likiang Snow Range, *Rock* 5374 (USNH), 5700 (USNH); Mount Habashan, north of Ndaku, north of the Likiang Snow Range, *Rock* 9645 (ANSP, GH, USNH); eastern slope of Mount Dyinaloko, northern peak of the Likiang Snow Range, *Rock* 10431 (GH, UC, USNH); Wei-si District, Yeh-chih, *C. W. Wang* 68362 (AA), 68641 (AA); Likiang Snow Range, *Yü* 15399 (AA); Upper Kiukiang Valley (Clulung), Chialahmuto, *Yü* 19734 (AA); no data, *Yü* 12807 (AA).

A rather hairy plant, usually of dwarf habit, with many divaricate branches near the base, and with the corolla often dotted with purplish spots.

93e. Pedicularis lutescens longipetiolata var. nov.

A typo speciei differt plantā nanā, hirsutā, ad 10 cm. longā, ad basim valde ramosā; foliis longe petiolatis, ovatis vel ovato-oblongis, ad 2.2 cm. longis et 1.2 cm. latis, profunde pinnatifidis; petiolis inferioribus 2.5 cm. longis, superioribus 1-1.5 cm. longis.

Type, under forests, at an altitude of 3600 meters, Tsa-wa-rung, Doola, Sikang, collected in flower, August 1935, by C. W. Wang, No. 65534; holotype in the herbarium of the Arnold Arboretum. Only collection seen. Flowers yellow.

This variety resembles the typical form of the species in the floral structures, but the dwarf habit, slender stem which is many-branched at base, and the long petiolate leaves distinguish it. The flowers are yellow throughout without any purplish spots.

94. Pedicularis laxispica sp. nov. Plate 22, fig. 77.

Planta perennis, radice lineari, vix crassā; caulibus singulis, erectis, 7-15 cm. longis, sparse pubescentibus, simplicibus, paucifoliatis; foliis radicalibus et caulinis, minoribus, paucis, oppositis vel ternatis, breviter petiolatis (petiolis ad 5 mm. longis, gracilibus, villosis), ovatis vel ovato-oblongis, 8-11 mm. longis, 4-6 mm. latis, utrinque pubescentibus, apice obtusis, basi late truncatis, pinnatifidis, lobis utrinque 6 vel 7 (ex margine ½ ad costam incisis), approximatis, oblongis, obtusis, ad 2 mm. longis 1.5 mm. latis, subintegris; inflorescentiis terminalibus spicatis, 3-6 cm. longis, paucifloris, floribus 5-7, oppositis, laxis, distantibus, subsessilibus vel breviter pedicellatis; bracteis foliaceis, breviter petiolatis vel subsessilibus, pinnatifidis, calycem superantibus; pedicellis ad 2 mm. longis; calyce cylindrico, 8-10 mm. longo, 3-4 mm. lato, membranaceo, paulo reticulato, antice subfisso, 5-dentato, dentibus lateralibus late ovatis, dentatis, basi leviter constrictis, dente posteriore deltoideo, acuminato, integro; corollā purpureā (?), circiter 2.5 cm. longā, glabrā: tubo erecto, calycem paulo superante, apice dilatato; galeā tubum aequante, basi erectā, superne falcatā, fronte rotundatā, apice obtusā, margine inferiore utrinque 4-5-dentatā, dentibus inferioribus longioribus, linearibus; labio inferiore circiter 1 cm. longo, lobis subaequalibus, margine fimbriatis, lobo medio prominente porrecto, apice emarginato, lobis lateralibus plerumque rotundatis; staminibus ad basim tubi insertis, filamentis glabris; stylo exserto; capsulis ignotis.

Type in northwestern Yunnan, field data not available, collected in flower, by T. T. Yü, No. 12598; holotype in the herbarium of the Arnold Arboretum. Flowers purplish (?). Only collection seen.

This species is near *P. lutescens*, but is readily distinguished by its laxly arranged flowers and the longer corolla-tube. The very small, short-petiolate leaves resemble somewhat those of *P. lutescens brevifolia*.

95. Pedicularis pseudostenocorys Bonati

Pedicularis pseudostenocorys Bonati, in Bull. Soc. Bot. France, 57, Sess. Extraord.: lix, 1911; Limpricht, in Repert. Sp. Nov., 20: 226, 1924. Bonati's type, "Yunnan (*Wilson*)," has not been seen.

Flowers yellow. Known from the original collection only. No specimen seen.

According to Bonati this species is close to *P. lutescens*, differing in the galea having only one tooth on each side of the lower margin, in the lobes of the lower lip being entire and sparsely ciliate, and in having two of the staminal filaments hairy.

96. Pedicularis stenantha Franchet

Pedicularis stenantha Franch., in Bull. Soc. Philom. Paris, VIII, 3: 149, 1891; Limpricht, in Repert. Sp. Nov. Beih., 12: 485, 1922; in Repert. Sp. Nov., 20: 227, 1924. Franchet's type, " Se-tchuen, circa Ta-tsien-lou," was collected by Soulié. This has not been seen.

Franchet originally indicated that the species belongs to the Lyratae and appears to be related to *P. lyrata* Prain. Franchet described another *P. stenantha* in 1901 (in Bull. Soc. Bot. France, 47: 36, 1901), this being an alternate-leaved plant (=*P. angustiflora* Limpricht). Limpricht in 1922 (l.c.) cited *Limpricht* 1668 and 1785 as representing *P. stenantha* Franch., 1891, but evidently he actually meant *P. stenantha* Franch., 1901.

Limpricht in 1924 (l.c.) referred to this species as, " Eine zweifelhafte zwischen *P. lyrata* Prain und *P. stenocorys* Franch. stehende Art." In Bonati's keys of this series in 1910 (Bull. Soc. Bot. France, 57, Mém. 18: 29, 1910), and 1921 (Notes Bot. Gard. Edinb., 13: 137, 1921), this species was not included. In the former treatment, (l.c., 32, 1910), he included *P. stenantha* Franch. in the series Flammeae, but mentioned that it is a very doubtful species; and apparently he meant *P. stenantha* Franchet of 1901. Without access to an actual specimen I also am not able to make out the exact status of the species. The original description is rather brief and inconclusive.

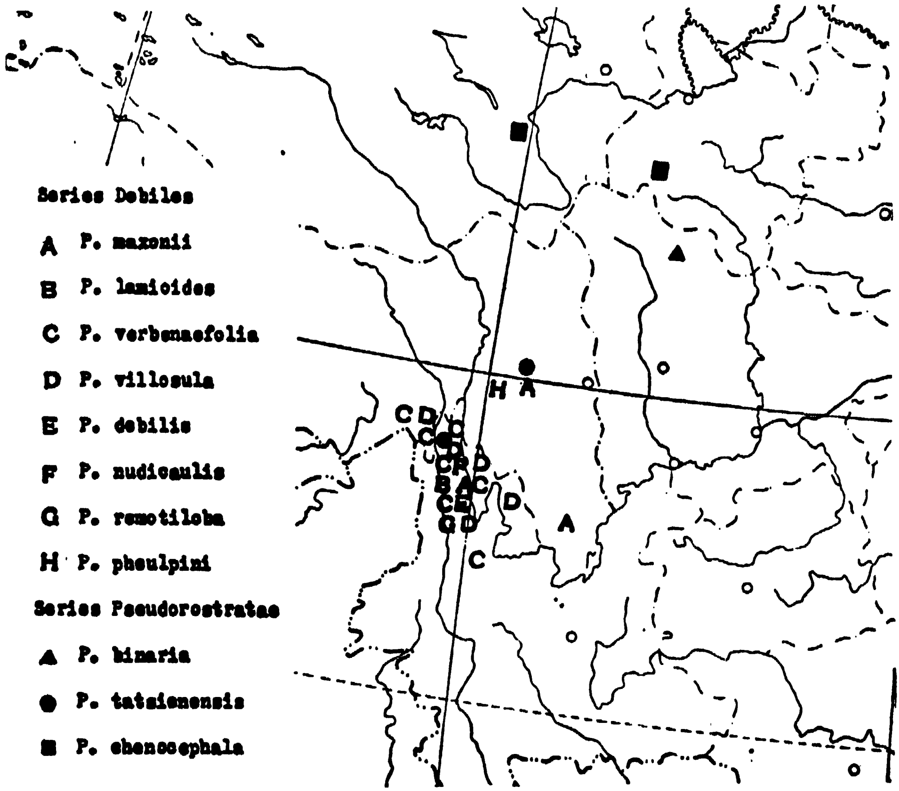
Series 27. Debiles

Debiles Prain, in Ann. Bot. Gard. Calcutta, 3: 72, 1890.

Low or tall plants, annual or perennial; roots slender and fascicled or single and thickened; stems single or branching at base, rarely branching above, glabrate to villose; leaves radical and cauline, long-petiolate to sessile, opposite, rarely opposite and ternate, ovate to lanceolate, palmatifid to palmatisect or pinnatifid to pinnatisect; inflorescences terminal, lax or compact; bracts foliaceous; calyx membranaceous, campanulate, usually 10-costate and non-reticulate, 5- dentate, the posterior teeth often entire and acute, the others broad, serrate to crenate, to rarely entire; corolla pink to purple, erect, the tube longer than the calyx, hairy or glabrous externally, the galea bidentate or usually entire, produced into a long, slender, horizontal, more or less straight beak, the lower lip 3-lobed, equal to subequal, the margins ciliate or glabrous; stamens inserted near the middle or top of the tube, the filaments all glabrous or 2 of them hairy.

About 12 species from eastern Himalaya to northwestern Yunnan and Sikang (Map 14).

The series Debiles as a whole is uniform in its characters and is easily recognized. The leaves are, in most cases, strictly opposite, and only rarely ternate. The corolla is erect, pink to purplish in color, and produced into a long slender beak more or less straight and horizontal. However, classification within the series appears to be confusing. Apparently too many species have been described on limited collections. A careful study, with



Map. 14.—Distribution of the series Debiles and Pseudorostratae.

the help of type specimens in some cases, has resulted in the reduction of a few species to synonymy. The more recent collections from southwestern China also help in shaping clearer concepts about the limits of a few species. The leaf-characters, variable as they are within each species, are nevertheless helpful in differentiating various species. A supplemental illustration, showing the general outlines of the cauline leaves of species where actual specimens are observed, is given (Text-figure 3).

The Indian species, *P. brevifolia* Don of the series Breviflorae Prain, has been credited to China by some authors. It is found that the Chinese plants are not of this Indian species but are the same as *P. villosula*. Bonati also described *P.* × *wettsteiniana*, a supposed hybrid, as possibly belonging to the series Breviflorae, but from his description it seems referable to *P. verbenaefolia*. Thus the series Breviflorae is not actually represented in China.

In alpine meadows, at altitudes of 3400 to 4150 meters in northwestern Yunnan. Flowers deep pink to purplish red. Flowering in late August and early September.

YUNNAN: Mekong-Salween divide, Nisselaka, *Handel-Mazzetti* 9942 (GH); Mekong-Salween divide, Sewalongba, *Yü* 22567 (AA), 22675 (AA).

A distinct species characterized by the broad, ovate, shallowly crenately lobed leaves, scaly-hirsute on both surfaces. These leaves are sessile to sub-sessile throughout. The calyx is membranaceous, more or less densely hirsute, and with one acute tooth and 4 broadly crenately lobed ones. The corolla-tube is slightly hirsute externally.

90. Pedicularis verbenaefolia Franchet Plate 22, fig. 80; text-fig. 3C.

Pedicularis verbenaefolia Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 549, fig. 34, 1888; in Mél. Biol., 12: 818, fig. 34, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 219, 1890; Bonati, in Bull. Soc. Bot. Geneve II, 5: 112, 1913; in Notes Bot. Gard. Edinb., 15: 167, 1926; Limpricht, in Repert. Sp. Nov., 20: 261, 1924; 23: 339, 1927; Staff Bot. Gard. Edinb., in Notes Bot. Gard. Edinb., 17: 47, 1929; Hand.-Maz., Symb. Sin., 7: 868, 1926. Franchet's type was from "Yunnan (Delavay! in Mus. Paris)." Three sheets of *Delavay* 956 are available, two in the Bonati Herbarium (1 ex Paris, 1 ex Berlin) and one in the herbarium of the New York Botanical Garden (ex Paris). The labels read: "Yunnan, in pratis montis Tsang-chan, supra Tali, alt. 4000 m., Delavay 956, 4, Aug. 1884." This number is probably the type as Forbes & Hemsley cited "Yunnan: meadows on mount Tsangshan at 4000 meters (*Delavay!*) Herb. Kew." It may be that more than one number was included in the type collection as Maximowicz mentioned that there were two forms, *minor* Franch., and *major* Franch. It appears that among the large series of specimens observed there are variations in size which intergrade with each other so that these forms are not clearly recognizable as such. Maximowicz gave the description simply as "*P. verbenaefolia* Franch. ined. Omnibus partibus *P. porrecta* Wall. persimilis et tantum filamentis longioribus totis pilosis distinguenda." However, in the type specimens examined as well as in those specimens credited to this species by later authors and undoubtedly identical, most flowers have both pairs of filaments glabrous and only rarely are the longer pair found to be sparsely hairy, such being always found in younger flowers. The original description of the species is very brief, hence a more detailed one is here given.

"*Pedicularis porrecta*" *sensu* Maxim., in Bull. Acad. St. Pétersb., 32: 550, 1888; in Mél. Biol., 12: 818, 1888; Bonati, in Notes Bot. Gard. Edinb., 5: 85, 1911; 7: 241, 1912; Limpricht in Repert. Sp. Nov., 20: 260, 1924; Hand.-Maz., Symb. Sin., 7: 867, 1926; *non* Wall. Maximowicz was the first who credited this Indian species as also occurring in China and cited *Delavay* 202, from Tsang Shan, Yunnan. Bonati referred *Forrest* 4492 to this species. This number is available for study. It is observed, as was also by Franchet (in Journ. Linn. Soc. Bot., 26: 211, 1890), that the Chinese plant is different from the Indian plant and is definitely not of the same species. But the Chinese plant is manifestly the same as *P. verbenaefolia*, which was originally described as having one pair of the filaments pilose, the only character supposed to differentiate it from *P. porrecta*. But as mentioned above, this character is not reliable for species differentiation in this case.

Pedicularis leiandra Franch. ex Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 211, 1890. Franchet's type, "Yunnan: in thickets near the summit of Tsangshan (*Delavay* ex *Franchet*)," is from the type locality of *P. verbenaefolia*. In the Bonati Herbarium there are two numbers, *Delavay* 1103 and 4751, both from Tsang Shan, which may or may not be of the type collection. Bonati referred this species to the synonymy of *P. porrecta* and was followed by Limpricht. Chinese plants named as *P. porrecta* by various authors are found to be different from the Indian *P. porrecta* Wall. and are now placed in the synonymy of *P. verbenaefolia*.

Pedicularis × *wettsteiniana* Bonati, in Notes Bot. Gard. Edinb., 8: 40, 1913; Limpricht, in Repert. Sp. Nov., 20: 261, 1924. The type, "'Eastern flank of the Tali Range.

Lat. 25° 40′ N.' G. Forrest No. 6894," in the Edinburgh Herbarium, has been seen. Also a photograph of it is in the herbarium of the Academy of Natural Sciences of Philadelphia. Bonati stated that this plant is intermediate and probably a hybrid of *P. porrecta* Wall. and *P. brevifolia* Don, both of which are Indian species. Chinese plants referred to the former by different authors are actually *P. verbenaefolia* and those referred to the latter prove to be *P. villosula*. But the type shows that *P. wettsteiniana* is the same as *P. verbenaefolia* as here interpreted, being a small-leaved form of the species.

Perennial; stems erect, single or several together, simple, 1.5-3 dm. or sometimes taller, glabrate or sparsely hirsute; leaves mostly cauline, opposite, rarely ternate, petiolate (petioles 0.5-1.5 cm. long, slightly winged), the lamina ovate, glabrate to sparsely pilose, pinnatifid to about one-half the distance to the midrib, the lobes 5-6 on each side, ovate-oblong, usually longer than wide, distinctly crenate to serrate, the apex more or less rounded; flowers in terminal spikes of 3-8 cm. long, the upper fascicles more or less compact, the lower disjunct; bracts campanulate, 5-7 mm. long, sparsely pilose along the veins, 5-dentate, the posterior linear-lanceolate, acuminate, entire, the others broad, distinctly palmately lobed and serrate; corolla purple, the tube about twice as long as the calyx, glabrous, the galea produced into a distinct and long beak, the lower lip 3-lobed, the lobes rounded, the margins finely ciliate, the mid-anterior lobe smaller and more distad; stamens inserted at the middle of the tube, the filaments all glabrous or sometimes one pair sparsely pilose; style exserted; capsules compressed-ovoid, about 1.4-1.7 cm. long and 5-7 mm. wide, acuminate.

Alpine meadows, on mountain slopes, at altitudes of 3300 to 4000 meters, in northwestern Yunnan and southern Sikang. Flowers purple. Flowering in August.

SIKANG: Tsarung, northern slopes of Mt. Kenichunpo, north of Sikitung, upper Salween River, *Rock* 22141 (NYBG, UC, UP, USNH); Tsarung, mountains west of Kaakerpo, Kokerla and Yundshi, *Rock* 23156 (CM, MBG, NYBG, UC, UP, USNH).

YUNNAN: Tsang Shan above Tali, *Delavay* 956 (ANSP, UCLA, NYBG), 1103 (UCLA), 4751 (B); Tse-kou, *Soulié* s.n. (UCLA), 1330 (ANSP, NYBG, UCLA), *Monbeig* 112 (ANSP, NYBG, UCLA); eastern flank of the Tali Range, *Forrest* 4492 (ANSP, UCLA), 6984 (RBGE), 28095 (ANSP); Tsang Shan Range, west of Tali, *Rock* 6340 (ANSP, UC, USNH); Fuchuan Range, west of Mekong-Salween divide and west of Wei-si, *Rock* 22728 (NYBG, UC, USNH); Wei-si District, Kangpu, *C. W. Wang* 64501 (AA), 64596 (AA); Che-tse-lo, *Tsai* 58046 (AA), 58271 (AA); Newahlung, Salween-Kiukiang divide, *Yü* 19260 (AA); Parolaka, Salween-Kiukiang divide, *Yü* 20633 (AA); Sewalongba, Salween-Kiukiang divide, *Yü* 22638 (AA); Sila, Mekong-Salween divide, *Yü* 22148 (AA), 22391 (AA); Chungtien Plateau, *Feng* 1640 (AA).

100. Pedicularis villosula Franchet

Key to the Varieties

A. Plant about 5-9, sometimes to 15 cm. tall, more or less densely villose; stems simple or branching at base; leaf-blades about 1 cm. long. ..... 100a. *P. v. typica*

AA. Plant 1-3, sometimes to 5-6 cm. tall, sparsely villose; stems simple; leaf-blades about 5-6 mm. long. .... 100b. *P. v. parvifolia*

100a. Pedicularis villosula typica

Plate 22, fig. 81; text-fig. 3D.

Pedicularis villosula Franch. ex Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 220, 1890; Limpricht, in Repert. Sp. Nov., 20: 260, 1924; Hand.-Mas., Symb. Sin., 7: 868, 1936. The type, "Yunnan: Likiang, near the perpetual snow (Delavay, ex Franchet)," has not been seen.

"*Pedicularis brevifolia*" *sensu* Maxim., in Bull. Acad. St. Pétersb., 32: 549, 1888; in Mél. Biol., 12: 817, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 205, 1890; Bonati, in Notes Bot. Gard. Edinb., 8: 40, 1913; Limpricht, in Repert. Sp. Nov., 20: 261, 1924; *non* D. Don. Maximowicz was the first to identify as this Indian species our Chinese plant. He cited *Delavay* s.n., above Lankong at 3000 meters, Yunnan. This number is represented by a duplicate sheet in the Bonati Herbarium with no less than ten specimens. These prove to be different from *P. brevifolia* D. Don of which authentic specimens from India are available for study. That Indian species has verticillate and much larger leaves. The Chinese plants have opposite leaves, and the anterior pair of staminal filaments are sparsely hirsute. They are identical with other specimens here referred to *P. villosula.*

Pedicularis handel-mazzetti Bonati, in Notes Bot. Gard. Edinb., 13: 124, 1921; Limpricht, in Repert. Sp. Nov., 20: 261, 1924; Hand.-Maz., Symb. Sin., 7: 868, 1936. The type, "West China:—Stony, moist pasture on the mountains of the Chungtien Plateau, Yunnan. Lat. 27° 55' N. Alt. 12,000 ft. Flowers rose. Aug. 1913,' G. Forrest, No. 10,776," from the Bonati Herbarium, passes to the University of California at Los Angeles, with isotype at the Academy of Natural Sciences of Philadelphia. According to Bonati's original description, the staminal filaments are all hairy. An examination of the type specimen shows that the longer pair are rather densely hairy, especially distally, but the shorter pair are glabrous. In general habit, as well as structure of the calyx and corolla (which is also hairy on the tube externally), the plant agrees exactly with *P. villosula,* and is undoubtedy identical.

Open stony pastures at altitudes of 2700 to 4420 meters, in northwestern Yunnan. Flowers rose to purplish red. Flowering in August and September.

SIKANG: Tsa-wa-rung, Nar-jou, *C. W. Wang* 66503 (AA); Muli, *Ward* 4817 (RBGE); Tatsienlu, *Cunningham* 305 (RBGE).

YUNNAN: Hee-chan-men above Lankong, *Delavay* s.n. (ANSP, UCLA); Yen-tze-hay, *Delavay* s.n. (ANSP, RBGE, UCLA); Tali Range, *Forrest* 7054 (RBGE); Chungtien Plateau, *Forrest* 10776 (ANSP, UCLA); eastern slopes of Likiang Snow Range, Yangtse watershed, *Rock* 9904 (ANSP, GH, UC, USNH); Atungtze, *C. W. Wang* 70208 (AA); Atungtse, Bei-mar-shan, *C. W. Wang* 69663 (AA); Wei-si District, Yeh-chih, *C. W. Wang* 68606 (AA); northern flank of Haba Snow Range, *Feng* 2094 (AA); no data, *Yü* 12968 (AA).

This species is characterized by the crenately lobed calyx-teeth, the hairy corolla-tube, the ciliate-margined lobes of the lower corolla-lip, and the villose anterior filaments. There is some variation in the degree of hairiness of the corolla-tube and the filaments, ciliateness of the margins of the lower lip, as well as length of the corolla-tube; these are apparently due to the age of the flowers.

100b. Pedicularis villosula parvifolia (Hand.-Maz.) Handel-Mazzetti

Pedicularis parvifolia Hand.-Maz., in Anz. Akad. Wiss. Wien, 57: 88, 1920; Limpricht, in Repert. Su. Nov., 20: 254, 1924. Handel-Mazzetti's original type was: "Ejusdem ditionis [Prov. Yünnan bor-occ.] in fossis nivalibus montis Piepun substr. calceo, 44-4700 m., leg. 11. VIII. 1914." This number, as stated by Handel-Mazzetti in 1936 (l.c.), is *Handel-Mazzetti* 4723. This has not been seen. In the United States National Herbarium there is a number, *Handel-Mazzetti* 3874, identified by him as *P. parvifolia.* A comparison of this and *P. villosula* shows that Handel-Mazzetti's later transfer is fully justified. The plant differs from typical *P. villosula* in the much lower stem and smaller leaves only, otherwise they are the same. However, I do not understand why Handel-Mazzetti stated, both in the original description of *P. parvifolia* and that of *P. villosula* var. *parvifolia,* "folia alterna." The specimen mentioned above has definitely only opposite leaves and he was clearly aware of this when he made his former species a variety of *P. villosula.*

Pedicularis subacaulis Bonati, in Notes Bot. Gard. Edinb., 15: 165, 1926, p.p.; Limpricht, in Repert. Sp. Nov., 23: 339, 1927, p.p. Bonati originally cited three numbers for this species: "'Yunnan: Peshwe River, among rocks. Flowers purple. Aug. 1922.' J. F. Rock. No. 5259. 'Yunnan: Eastern slopes of Likiang Snow Range, Yangtze watershed, Nadchua Shi Luphu Chua. Flowers purple. 14,500 ft. July 1922.' J. F. Rock. No. 5473. Also 'Flowers purple. Aug. 1923.' J. F. Rock. No. 9904." Duplicates of *Rock* 9904 are in the Gray Herbarium, the herbarium of the University of California, and the United States National Herbarium. A duplicate of *Rock* 5473 is in the United States National Herbarium, and one of 5259 is in the New York Botanical Garden. These three numbers represent two different elements. *Rock* 5259 and 5473, to which the description mainly applies, are the same as here called *P. villosula* Franch. var. *parvifolia* (Hand.-Maz.) Hand.-Maz. *Rock* 9904 is identical with typical *P. villosula*. The name *P. subacaulis* Bonati was first reduced into the synonymy of *P. villosula* by Handel-Mazzetti (Symb. Sin., 7: 868, 1936). When he first described the species he put it in "Sect. Longirostres § Siphonanthae A Eusiphonanthae Prain" and mentioned that it is an isolated species probably near the series Pumiliones. Consequently Limpricht (in Repert. Sp. Nov., 20: 254, 1924) established for it the series "Parvifolia" which was placed before Pumiliones. Probably Limpricht did not have access to any specimen, and so was misled by Handel-Mazzetti's original description.

Pedicularis villosula var. *parvifolia* (Hand.-Maz.) Hand.-Maz., Symb. Sin., 7: 868, 1936.

At altitudes of 3850 to 4850 meters, in northwestern Yunnan. Flowers purple. Flowering from July to September.

YUNNAN: Yulung-shan, near Likiang, *Handel-Mazzetti* 3874 (USNH); eastern slopes of the Likiang Snow Range, *Rock* 5259 (NYBG), 5473 (USNH); between Likiang and Youngning, *Rock* 17330 p.p. (USNH).

101. Pedicularis debilis Franchet Plate 22, fig. 82; text-fig. 3E.

Pedicularis debilis Franch. ex Maxim., in Bull. Acad. St. Pétersb., 32: 549, 1888; in Mél. Biol., 12: 817, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 207, 1890; Bonati, in Notes Bot. Gard. Edinb., 5: 84, 1911; 7: 241, 1912; Limpricht, in Repert. Sp. Nov., 20: 261, 1924. The type, "China: Yunnan, sylvis ad pedem glaciei Likiang (Delavay! in Mus. Paris)," has not been seen. This new species of Franchet, contrary to others given in Maximowicz's extensive treatment, was not illustrated. The following specimens are identified on the basis of the original description. They agree very closely in all details.

In northwestern Yunnan.

YUNNAN: field data not available, *Yü* 8928 (AA), 12653 (AA).

This species is possibly an annual, with slender fascicled roots. The stem is single and unbranched throughout, rather slender, and sparsely hirsute. The radical leaves are very long-petiolate and pinnatisect with the segments 4- or 5-paired, while the upper leaves are subsessile and crenately pinnatifid with the lobes 2- or 3-paired. The flower is characterized by its tridentate lateral calyx-teeth and ciliate-margined lobes of the lower corolla-lip. These lobes are sometimes fimbriately margined. This species is clearly related to *P. liana* and *P. remotiloba*, but is readily distinguished by its tridentate calyx-teeth and ciliate lower corolla-lip.

102. Pedicularis liana Pennell nom. nov.[22] Plate 23, fig. 83; text-fig. 3F.

Pedicularis nudicaulis Bonati, in Bull. Soc. Bot. France, 55: 310, 1908; Limpricht, in Repert. Sp. Nov., 20: 260, 1924. The type, "Tsekord, juillet 1903 (*R. P. Soulié*) nº 1169, mélange à *P. likiangensis* F.," has not been seen. The type locality is usually spelled Tseku, in northwestern Yunnan. This species has so far been known only from its original collection. The following specimen is identified as belonging to the species on the basis of the original description. Not *P. nudicaulis* Koch, 1843.

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[22] Dr. Li's failure to notice that Bonati's name for this species was preoccupied, gives me the opportunity of proposing the name now presented. F. W. P.

In northwestern Yunnan. Flowering in July.

YUNNAN: field data not available, *Yü* 12446 (AA).

The leaves of this species vary from palmatilobed to subpalmatisect to somewhat pinnatilobed and pinnatisect. The lobes of the lower corolla-lip are more or less equal, ovate, and somewhat obtuse to subacute at the apex.

103. **Pedicularis remotiloba** Handel-Mazzetti Plate 23, fig. 84; text-fig. 3G.

Pedicularis remotiloba Hand.-Maz., Symb. Sin., 7: 868, pl. 15, fig. 7, 1936. A duplicate of the type, "NW.-Y[unnan]: Offener Rasen der ktp. und Hg. St. des birm. Mons. im obersten Doyon-lumba zwischen Mekong und Salwin, 28° 9', Glimmerschiefer, 3800 bis 4200 m, 5. VIII. 1916 (9698)," is in the Gray Herbarium.

Grassy slopes in alpine regions at altitudes of 3800 to 4200 meters, in northwestern Yunnan. Flowers pink. Flowering in August.

YUNNAN: Mekong-Salween divide, Doyon-lumba, *Handel-Mazzetti* 9698 (GH); Mekong-Salween divide, Sila, *Yü* 22256 (AA); Chawchi Pass, *Farrer* 1879 (RBGE).

This species is characterized by its low delicate habit, its small, profoundly palmately lobed leaves, and its lanceolate-acute nearly entire calyx-teeth. It is most closely related to *P. liana*, but can be readily distinguished by its bidentate galea.

104. **Pedicularis pheulpini** Bonati

Pedicularis pheulpini Bonati, in Bull. Soc. Bot. France, 55: 247, 1908; Limpricht, in Repert. Sp. Nov., 20: 260, 1924.[28] The type, from Sikang, "Yargong, pelouses sèches des montagnes (*R. Soulié*), n° 3351, août 1903," has not been seen.

In Sikang. Flowers purple. Flowering in August. Known from the original collection only. No specimen seen.

This species, according to its description, is characterized by the lanceolate 8-10-pinnatifid leaves, the lower being long-petiolate, and by the bidentate galea. It is described as an annual. Its relationships are apparently with *P. liana* and *P. remotiloba*. To the latter it is particularly close on account of the bidentate galea. However, the exact status of the species is not very clear, as Bonati himself identified a specimen which is clearly his *P. sabaensis*, a species which is very distinct from the group of plants under consideration, as *P. pheulpini*. An examination of the type, therefore, is imperative.

SECTION IX. DOLICHOPHYLLUM

Low or usually tall plants; stems single or usually several to many together, simple; leaves mostly radical, very long-petiolate, the cauline leaves usually few, opposite to ternate, distinctly petiolate; inflorescences racemose, long or short; calyx campanulate to cylindric, 5-dentate, the teeth equal to unequal, entire to serrate; corolla with the tube longer than the calyx; galea with the apex either bidentate or beaked.

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[28] Bonati, in Notes Bot. Gard. Edinb., 15: 165, 1926; Limpricht, in Repert. Sp. Nov., 23: 339, 1927, identified *Rock* 10628 from Likiang, Yunnan, as *P. pheulpini*, but the collection is actually *P. sabaensis*.

This section is closely related to Brachyphyllum and is apparently derived from the same stock. But the species have larger, longer-petiolate, mostly radical, and more dissected leaves, and they show a wider range extending from the Caucasus Mountains through central Asia and the Himalayas to Sikang, Yunnan and Szechuan in China.

In China the Section includes three Series.

Series 28. Cernuae ser. nov.

Tall perennials; stems robust, fleshy, many together, simple; leaves mostly radical, long-petiolate and much larger than the cauline, the cauline shorter-petiolate, opposite, ovate-oblong, pinnatifid, the lobes pinnatifid; inflorescences in conspicuous racemes, the flowers short-pedicillate, many, dense, showy; calyx cylindric, the teeth 5, lanceolate, serrate; corolla pink, the tube erect, slightly longer than the calyx, the galea erect proximally, slightly bending distally, with a protuberance at the middle of the lower margin on each side, the apex truncate, with 1 tooth on each side of the lower margins.

Two species in northwestern Yunnan, southern Sikang, and northern Burma (Map 13).

Pedicularis cernua was originally placed in the Lyratae. In view of its manifest difference in habit from other species of that series, it is here segregated to form a separate series. It is especially characterized by the numerous long-pedicelled profoundly dissected radical leaves.

105. Pedicularis cernua Bonati

Key to the Varieties

A. Leaves ovate-oblong, about 4-5.5 cm. long and 2-2.5 cm. wide, deeply pinnatifid, the lobes 6- or 7-paired, linear, deeply lobed; galea with distinct subulate teeth. 105a. *P. c. typica*

AA. Leaves broadly ovate, about 3-4 cm. long and 2.5-3.5 cm. wide, pinnatifid, the lobes 3-5-paired, ovate, crenately lobed; galea with inconspicuous deltoid teeth. 105b. *P. c. latifolia*

105a. Pedicularis cernua typica Plate 23, fig. 85.

Pedicularis cernua Bonati, in Bull. Soc. Bot. France, 54: 373, 1907; Staff Bot. Gard. Edinb., in Notes Bot. Gard. Edinb., 17: 54, 1929; Limpricht, in Repert. Sp. Nov., 20: 226, 1924; Hand.-Mas., Symb. Sin., 7: 855, 1936. Bonati cited two numbers: "Tsekou n° 1086; Pila n° 1168, *Soulié* (1903)." Two specimens of *Soulié* 1168 from the Bonati Herbarium are available for study, one of them bearing Bonati's brief description in his own handwriting. It should be accounted the type; it will pass to the Academy of Natural Sciences of Philadelphia, and the other isotype to the University of California at Los Angeles. "Pila" is a typographical error, as the original label read "Sila, Tsekou," which is in northwestern Yunnan. Three different dates of collecting "18 Juillet 1889, 18 Juillet 1893, 8 Juillet 1903," appear on the labels. On the same sheet with Bonati's own description there is an envelope attached containing fragments of flowers of *Kingdon Ward* 3400 from Upper Burma which evidently belong to this same species. This particular number is also cited by Limpricht (l.c.).

Alpine meadows, at altitudes of 3800 to 4000 meters, in northwestern Yunnan and southern Sikang. Flowers pink, speckled with red spots. Flowering from July to August.

SIKANG: Tsarung, mountains of Tjonatong, upper Salween River, *Rock* 22319 (NYBG, UC, UP, USNH); western range of Mekong on Kaakerpo, Dokerla and Tsarung, *Rock* 22924 (NYBG, UC, UP), Chawchi Pass, *Farrer* 1704 (RBGE).

YUNNAN: Tsekou, Sila, *Souliė* 1168 (ANSP, UCLA); Mekong-Salween divide, *Forrest* 14248 (ANSP, UCLA); Fuchuan range, west of the Mekong-Salween divide and west of Weisi, *Rock* 22740 (NYBG, UC, UP), 23265 (NYBG, UC, UP); mountains of Nakela, east of Yuragan, Mekong-Salween divide, *Rock* 23114 (NYBG, UC, UP, USNH), 23426 (NYBG, UC, UP); Mekong-Salween divide, Sila, *Yü* 22137 (AA), 22379 (AA); Che-tse-lo, Pi-lo-shan, *Tsai* 58044 (AA).

A characteristic species, readily distinguished by its numerous long-petiolate radical leaves, and the reddish flowers with a protuberance on each side of the lower margins of the galea. Bonati, in his original description, described the calyx as " lobis 5, linearibus, lanceolatis, summo vix dilatato, inciso," and later in his keys (in Bull. Soc. Bot. France, 57, Mém. 18: 29, 1910; in Notes Bot. Gard. Edinb., 13: 137, 1921), said "teeth of calyx entire." It is found that there are usually 3 or 4 long linear teeth which are deeply dentate and 1 or 2 smaller deltoid teeth which are entire.

105b. **Pedicularis cernua latifolia** var. nov.

A typo speciei differt foliis radicalibus late ovatis, 3-4 cm. longis, 2.5-3.5 cm. latis, pinnatifidis, lobis utrinsecus 3-5, ovatis, ad 1.5 cm. longis et 1 cm. latis, irregulariter crenato-lobulatis; dente galeae deltoideo, inconspicuo.

Type, at upper Kiukiang Valley (Clulung), Tsungum, Yunnan, in alpine grassland at an altitude of about 4200 meters, collected in flower, August 8, 1938, by T. T. Yü, No. 19784; holotype in the herbarium of the Arnold Arboretum. Only collection seen. Flowers light pink with purple dots.

Series 29. Pseudorostratae

Pseudorostratae Limpricht, in Repert. Sp. Nov., 20: 243, 1924.

Low plants; stems simple or many, erect or ascending, glabrate or pubescent; leaves generally long-petiolate, mostly radical and a few cauline, opposite or 3-verticillate, pinnatisect, the segments pinnatifid; flowers in terminal short compact racemes; calyx campanulate, 5-dentate, the teeth equal to unequal, the posterior frequently elongated, triangular, subentire, the others ovate and serrate; corolla purple, straight and erect, the tube longer than the calyx, slightly enlarged distally, the galea produced into a beak, the lower lip 3-lobed, the mid-anterior lobe cucullate or slightly acute at the apex; stamens inserted near the middle of the corolla-tube, the filaments glabrous or hairy.

Limpricht combined Prain's Pseudocaespitosae and Pseudoasplenifoliae (in Ann. Bot. Gard. Calcutta, 3: 84, 1890) into a single series Pseudorostratae, of which he gave no description. In view of their close relationships, this course seems justified. Prain's Pseudoasplenifoliae was based on *P. schizorrhyncha* Prain alone, a species of the eastern Himalaya region in Sikkim, Chumbi, etc.

The series Pseudorostratae, as outlined by Limpricht, includes species from the Caucasus through Central Asia to the eastern Himalayas. The Chinese species are found in northern Szechuan, Sikang, and northwestern Yunnan (Map 14).

Among the Chinese species enumerated below, two, *Pedicularis tatsienensis* and *P. chenocephala* are evidently closely related as shown by structural details of their flowers. The third species, *P. binaria,* however, differs from the other two notably in the mid-anterior lobe of the corolla-lip being cucullate at the apex. It may eventually prove it should be separated from the other two, but unfortunately specimens of it are not at present available for study. In the cucullate mid-anterior lobe of the corolla-lip, this species is probably related to *P. conifera* of the series Coniferae.

The Pseudorostratae are clearly related to the series Cernuae which has beakless but toothed corolla. In general habit as well as the fundamental characters of the flowers certain species of the present series are close to *P. cernua.*

Key to the Chinese Species

A. Plant annual; margin of lower lip of corolla entire and ciliate, the mid-anterior lobe broadly rounded, the apex cucullate; 2 of the staminal filaments hairy distally. .... 106. *P. binaria*

AA. Plants perennial; margin of lower lip of corolla sparsely dentate and glabrous, the mid-anterior lobe broadly ovate, the apex slightly acute; all staminal filaments glabrous.

  B. Plant lower, 10 cm. or less high; flowers smaller, about 2.5 cm. or less long; beak longer, more slender and distinct, about 2.5 mm. long. 107. *P. tatsienensis*

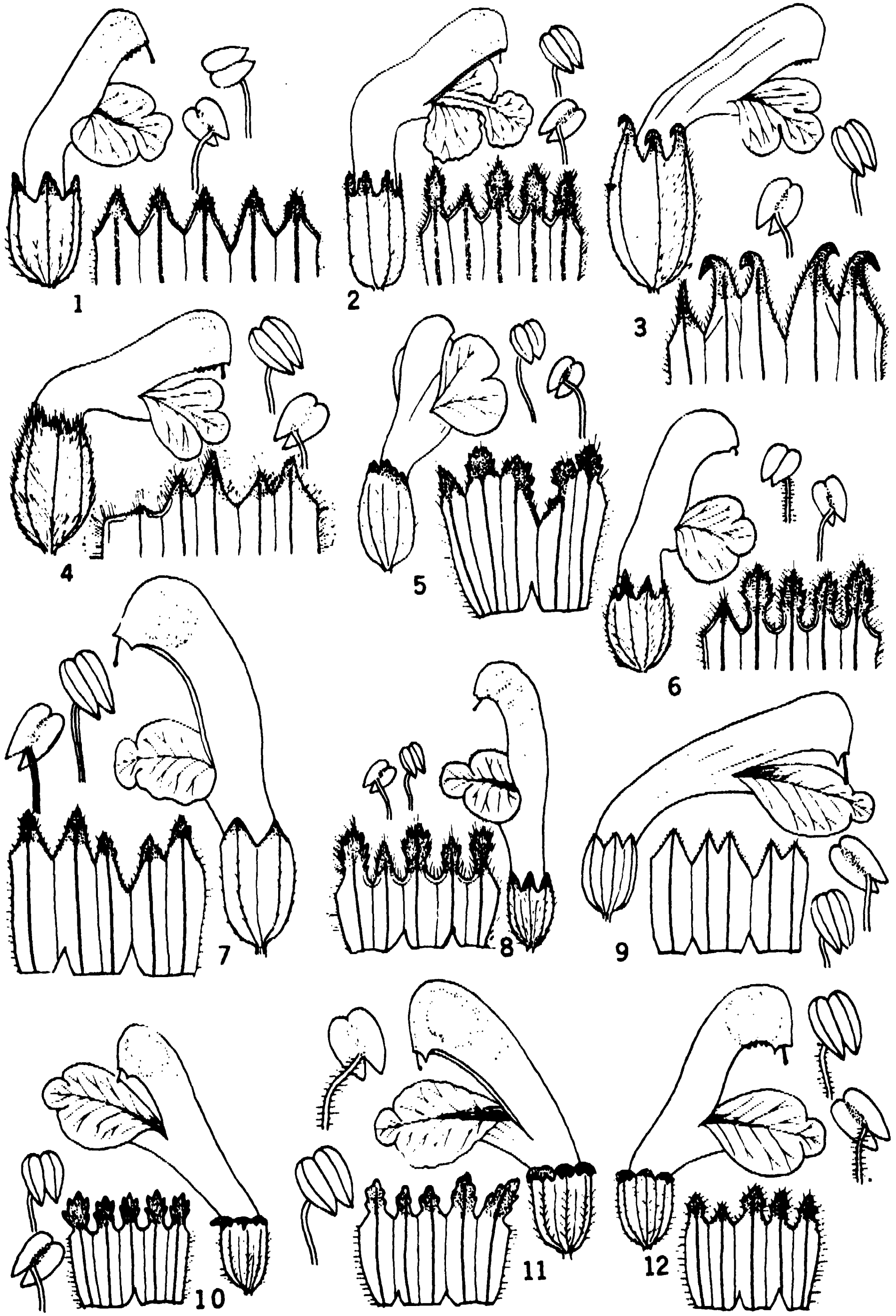
  BB. Plant taller, 12 cm. or more high; flowers larger, about 2.8 cm. or more long; beak shorter, scarcely 1.5 mm. long. .... 108. *P. chenocephala*

106. Pedicularis binaria Maximowicz

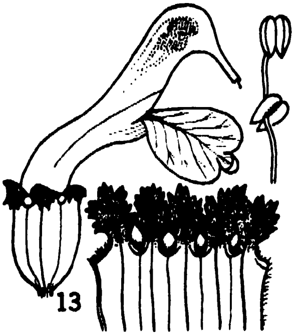
Pedicularis binaria Maxim., in Bull. Acad. St. Pétersb., 32: 579, fig. 88, 1888; in Mél. Biol., 12: 861, fig. 88, 1888; Forbes & Hemsl., in Journ. Linn. Soc. Bot., 26: 205, 1890; Limpricht, in Repert. Sp. Nov., 20: 244, 1924. The type, "prov. Szetschuan parte boreali: ad fontes fl. Atu-Lunwa (Potanin, 1885)," has not been seen.

In northern Szechuan. No specimen seen.

This species, according to the original description and illustration, differs from *P. tatsienensis* and *P. chenocephala,* in the lower lip being ciliate-margined and the mid-anterior lobe being cucullate. In the last mentioned character it resembles *P. conifera* which is supposed to be of very different habit. Specimens of neither species have been seen for the present study.



LI: PEDICULARIS IN CHINA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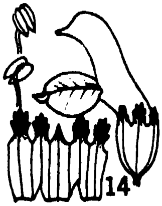
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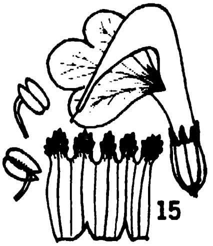
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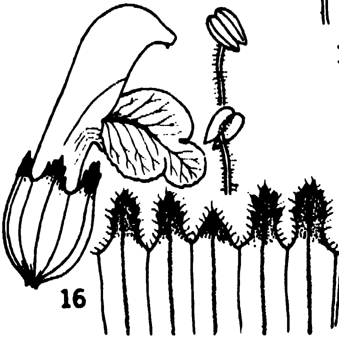
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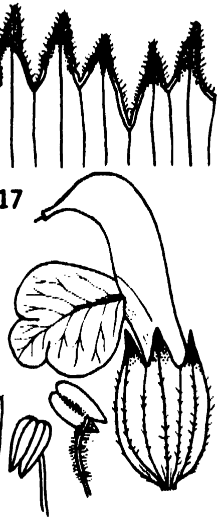
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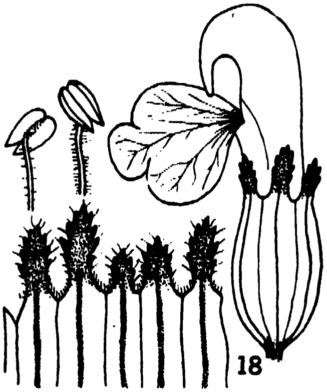
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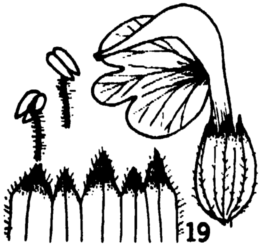
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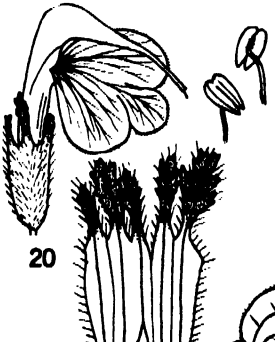
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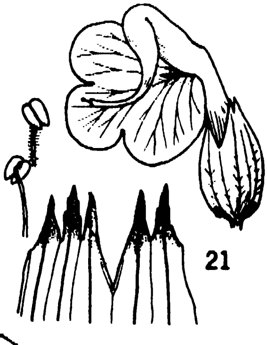
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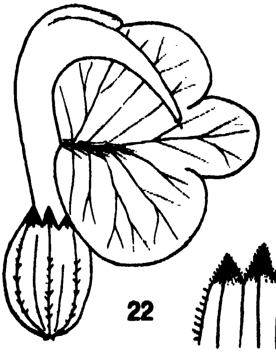
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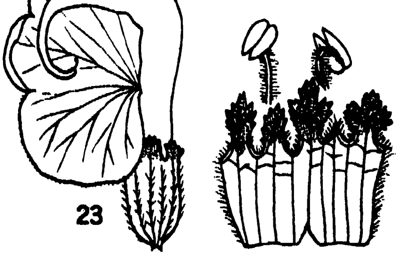
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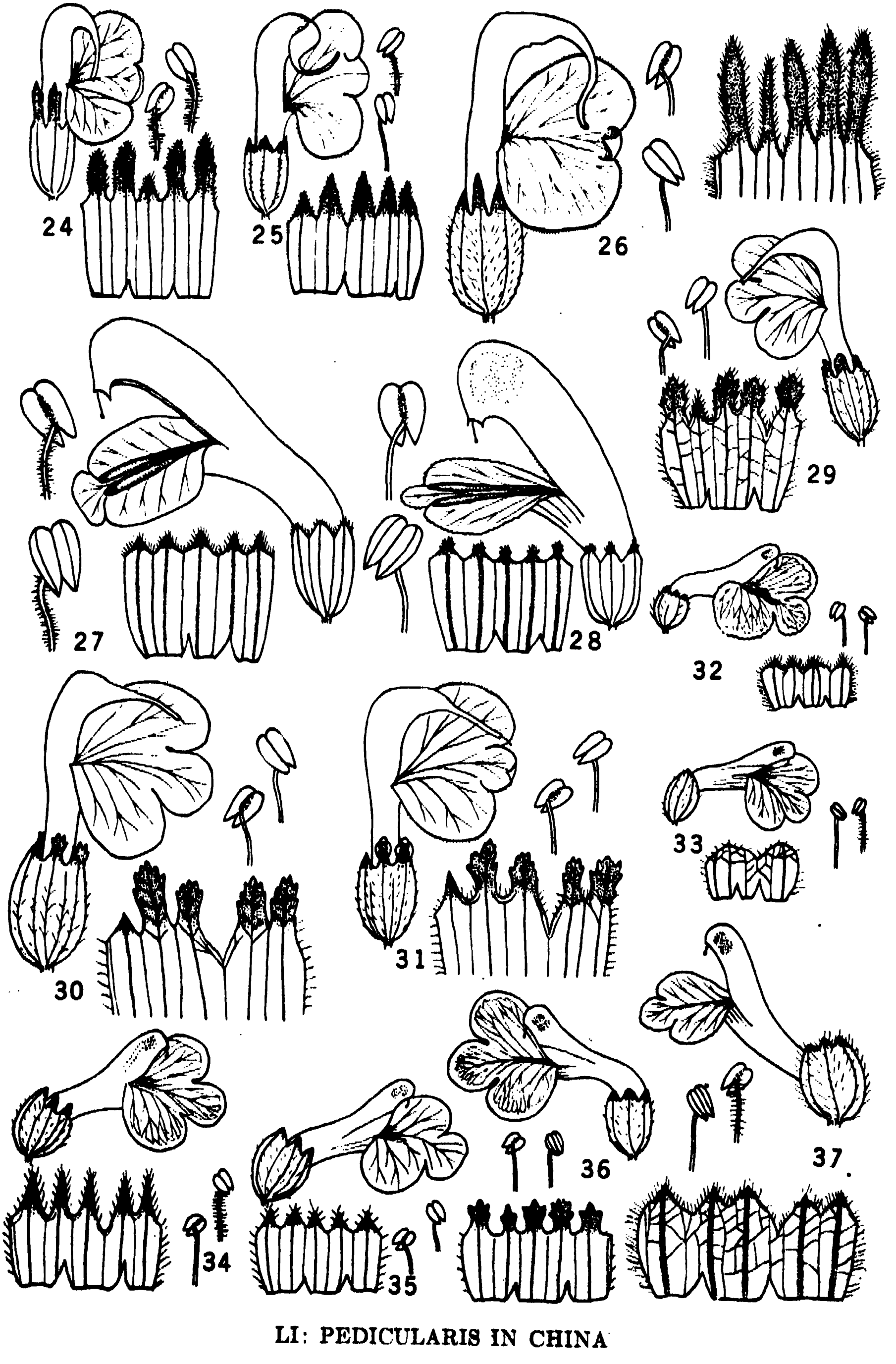

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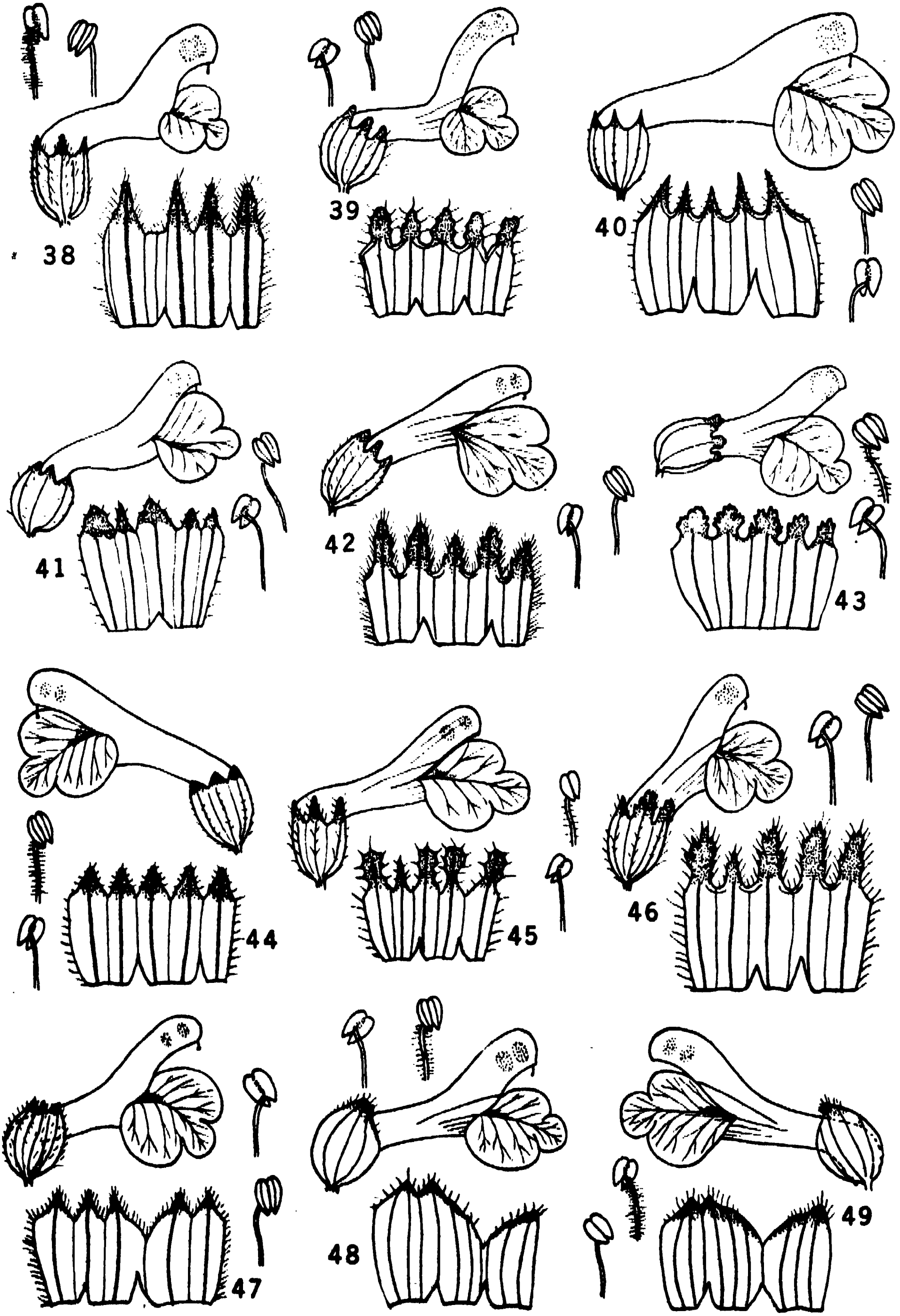

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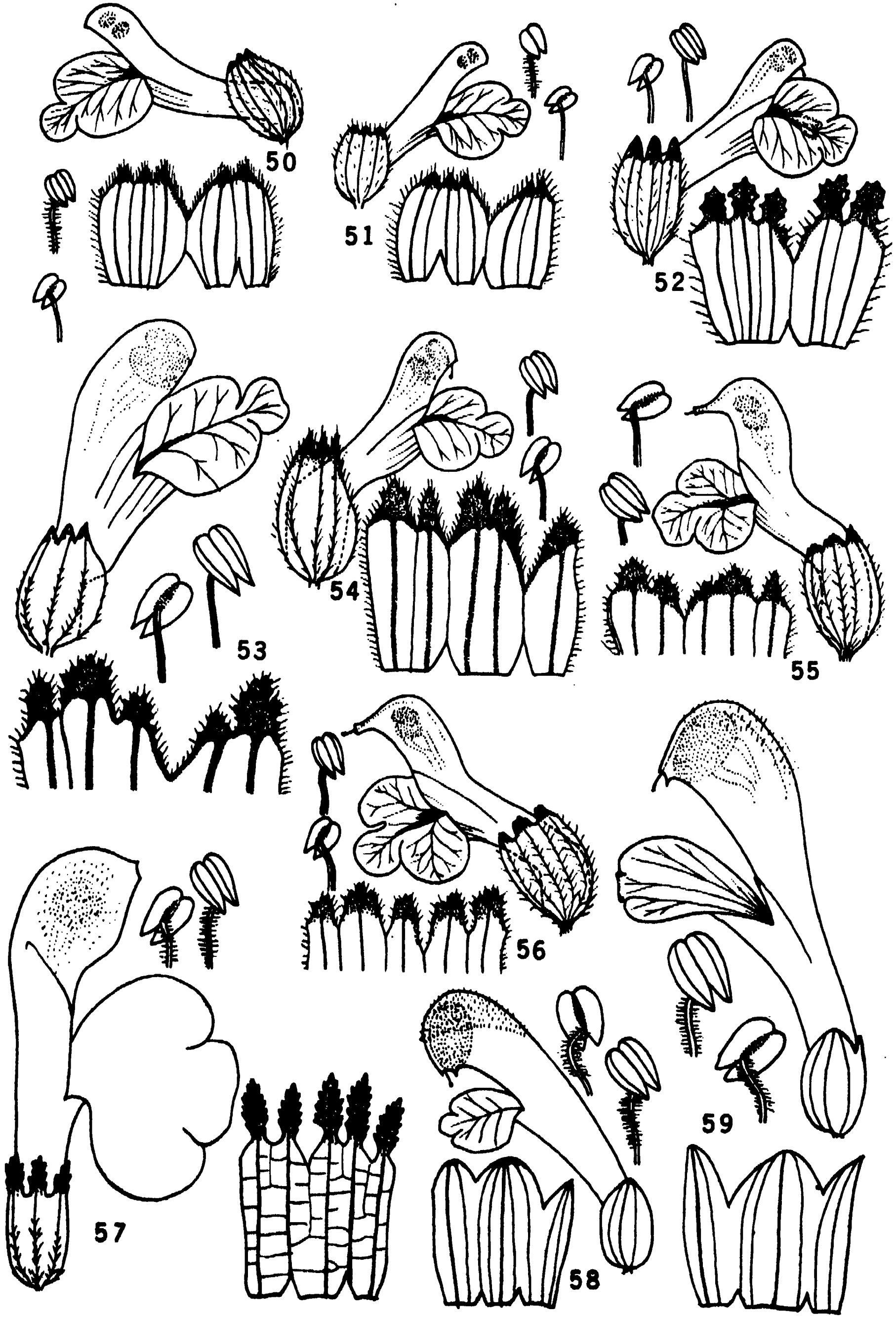

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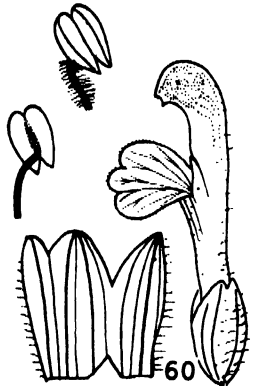

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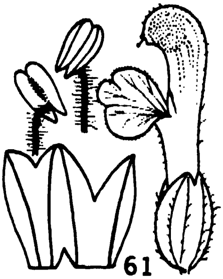

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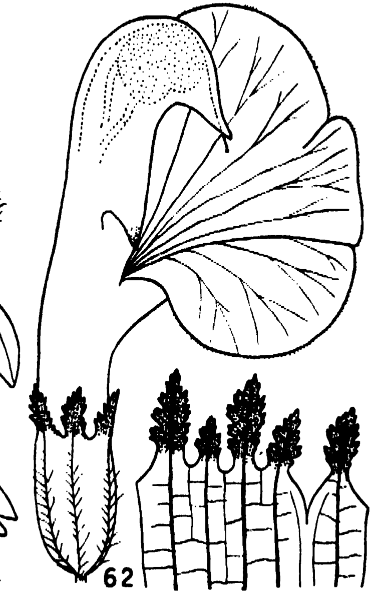

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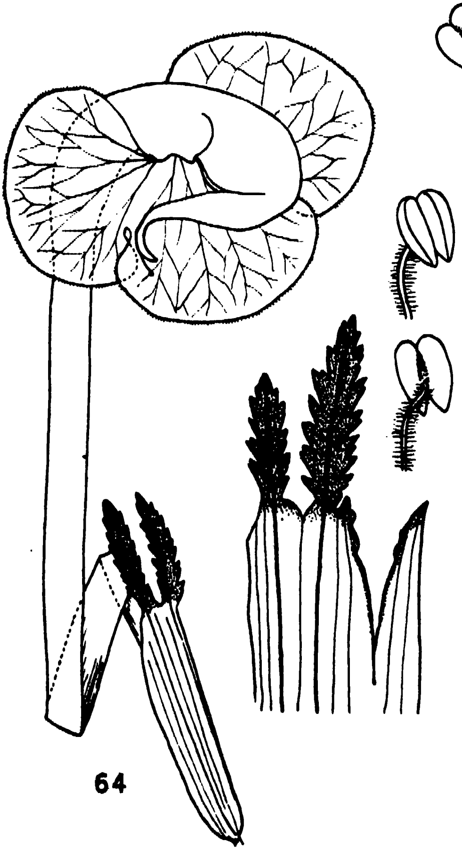

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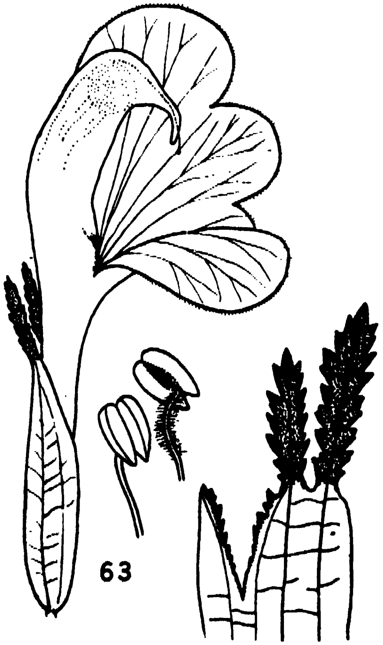

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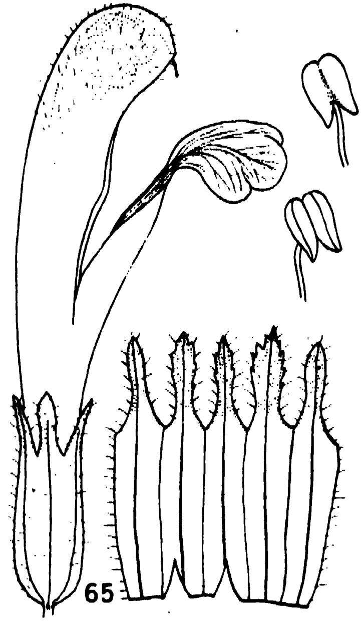
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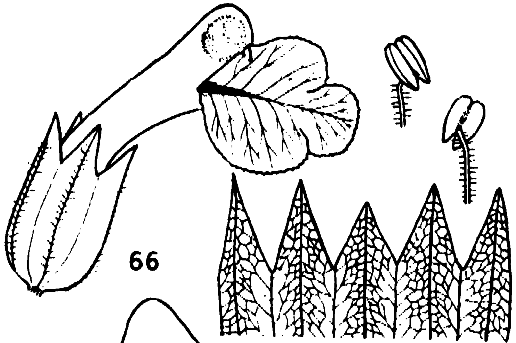
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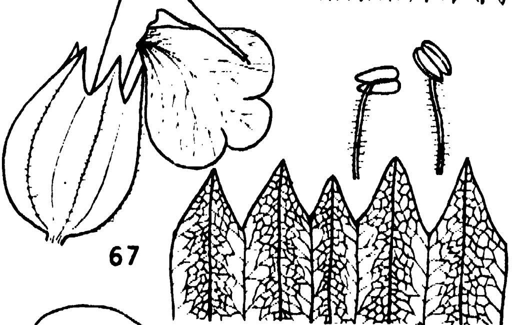
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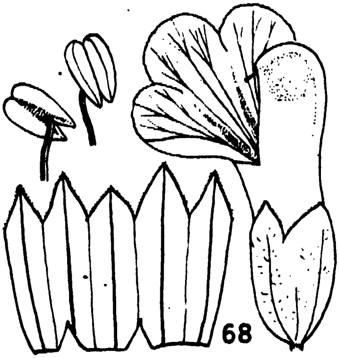
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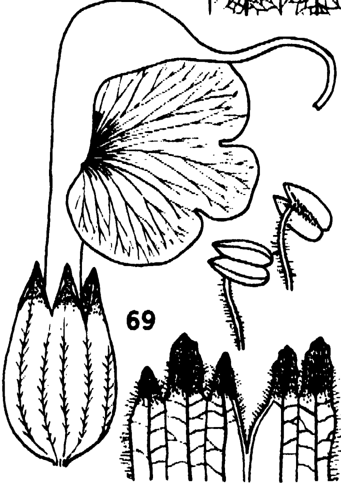
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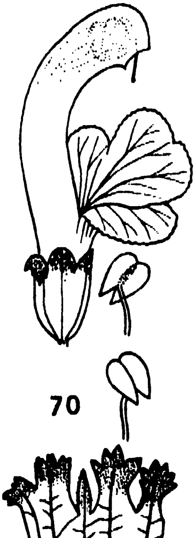
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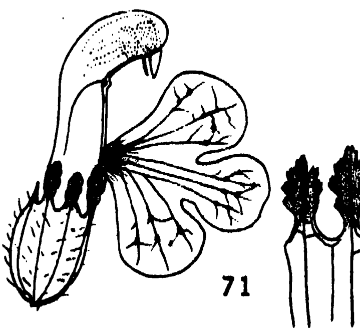
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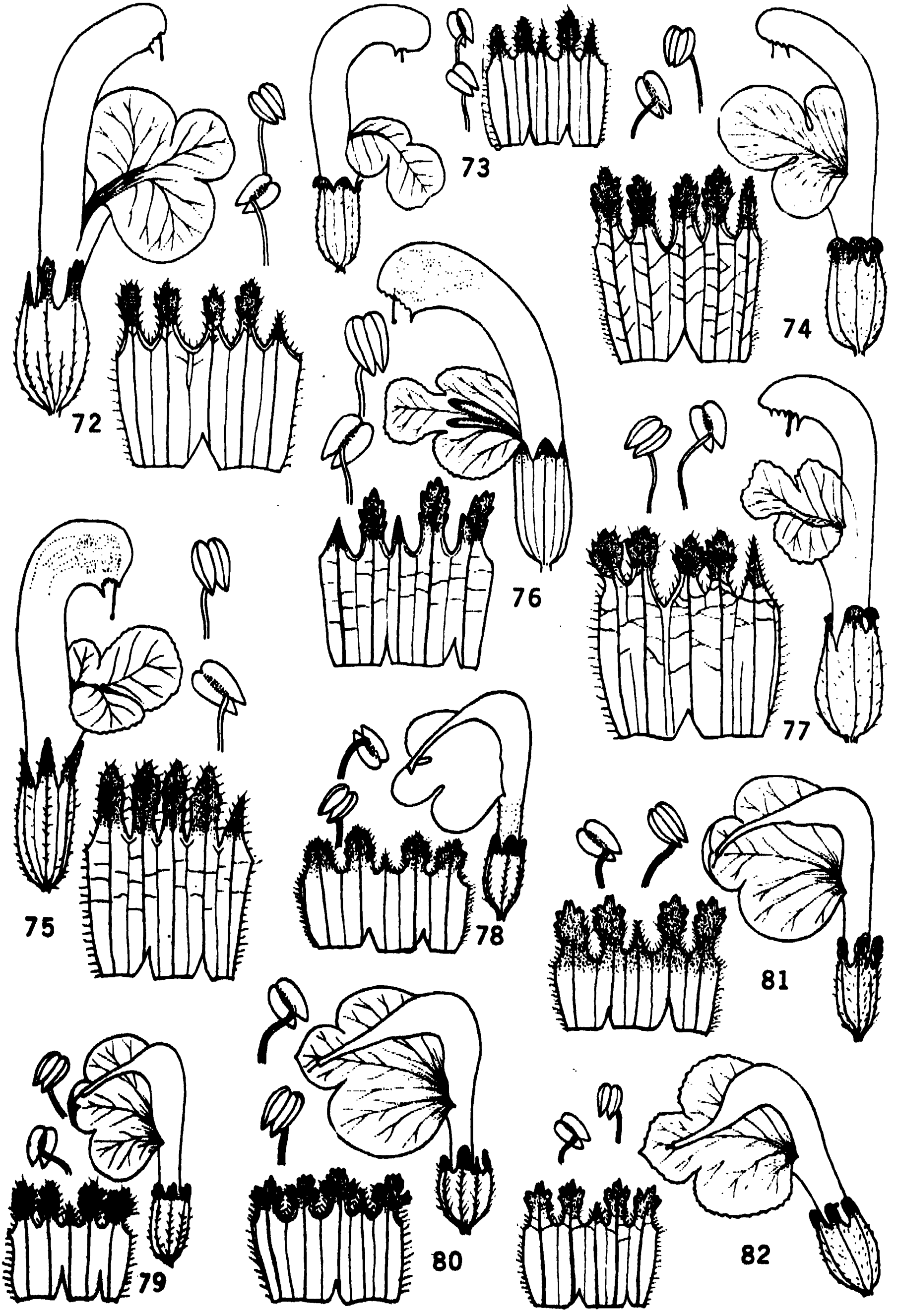

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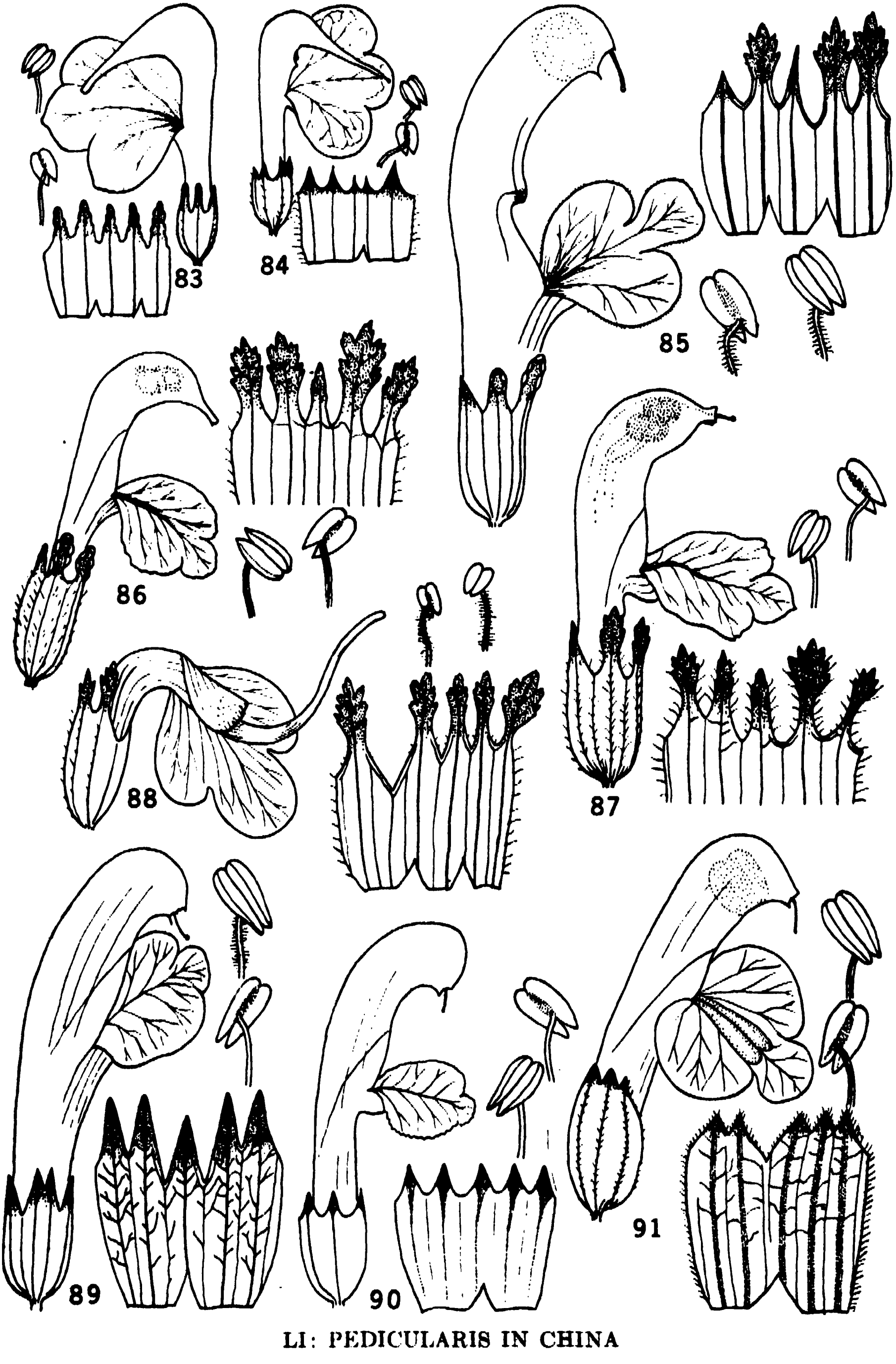

LI: PEDICULARIS IN CHINA

ABSTRACT OF MINUTES OF THE PROCEEDINGS OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

February 17, 1948

One hundred and thirty-sixth Annual Meeting of the Academy.

Four hundred and five members and guests present.

President Charles M. B. Cadwalader in the Chair.

The Assistant Treasurer, John E. Bowers, presented a report covering the finances of the institution.

The Managing Director, H. Radclyffe Roberts, presented a report for the year 1947, covering the work of all the scientific departments, as well as the Library, Educational, Museum Exhibits and Photographic departments. Among the important events of the year he reported the following:

Two new habitat groups were opened: the Desert Sheep Group from Mexico, collected by Mr. William K. Carpenter and a gift from him and his father, Mr. R. R. M. Carpenter; and the Wild Yak Group in the new Asiatic Hall, collected by the late Mr. Brooke Dolan II, and a gift of our members, especially Mrs. Thomas J. Dolan. Also, the Academy sponsored four expeditions to various parts of the world, during the year.

The Academy's Lecture Hall has been improved by the addition of two new movie projectors, a new screen and a mechanically operated curtain, all the gift of one of our Trustees, Mr. R. R. M. Carpenter.

A new course in biology entitled, " Fundamentals of Systematics " was begun for University students of graduate level. The neighboring universities and colleges, by a cooperative plan, gave their respective students academic credits for taking the course.

Report was made of the death during the year 1947 of Mr. William J. Fox, former Librarian of the Academy, who for 55 years cared for our library.

Mr. James A. Fowler was appointed in September as the new Director of Education, to replace Mr. Charles E. Mohr.

During the year a total of 204 new members were elected to the Academy in the following classes: Annual, 152; Junior, 44; Contributing, 5; Life, 3. Changes in membership since the last report were as follows: Junior to Annual, 2; Annual to Life, 1. During the year 1947 the Academy lost 37 members by death.

The next order of business was the election of Trustees. The following individuals were nominated, as prescribed by the By-Laws of the Academy, and elected to the Board of Trustees for a period extending to the Annual Meeting, 1951: R. R. M. Carpenter, G. Dawson Coleman, James E. Gowen.

The President then introduced Dr. Ruth Patrick of the staff of the Academy, who addressed the meeting on the subject, " The Living World of Lakes and Streams."

Following Dr. Patrick's address, an informal reception with refreshments was held in the Reading Room of the Academy's Library.

ELECTION OF OFFICERS

At a meeting of the Board of Trustees of the Academy held March 17, 1948, the following officers were elected:

President: Charles M. B. Cadwalader

Vice-President: Edwin G. Conklin

Vice-President: R. Meyer de Schauensee

Managing Director: H. Radclyffe Roberts

Treasurer: Brandon Barringer

Secretary and Assistant Treasurer: John E. Bowers

Corresponding Secretary: James A. G. Rehn

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